Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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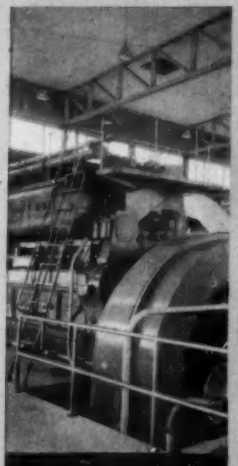

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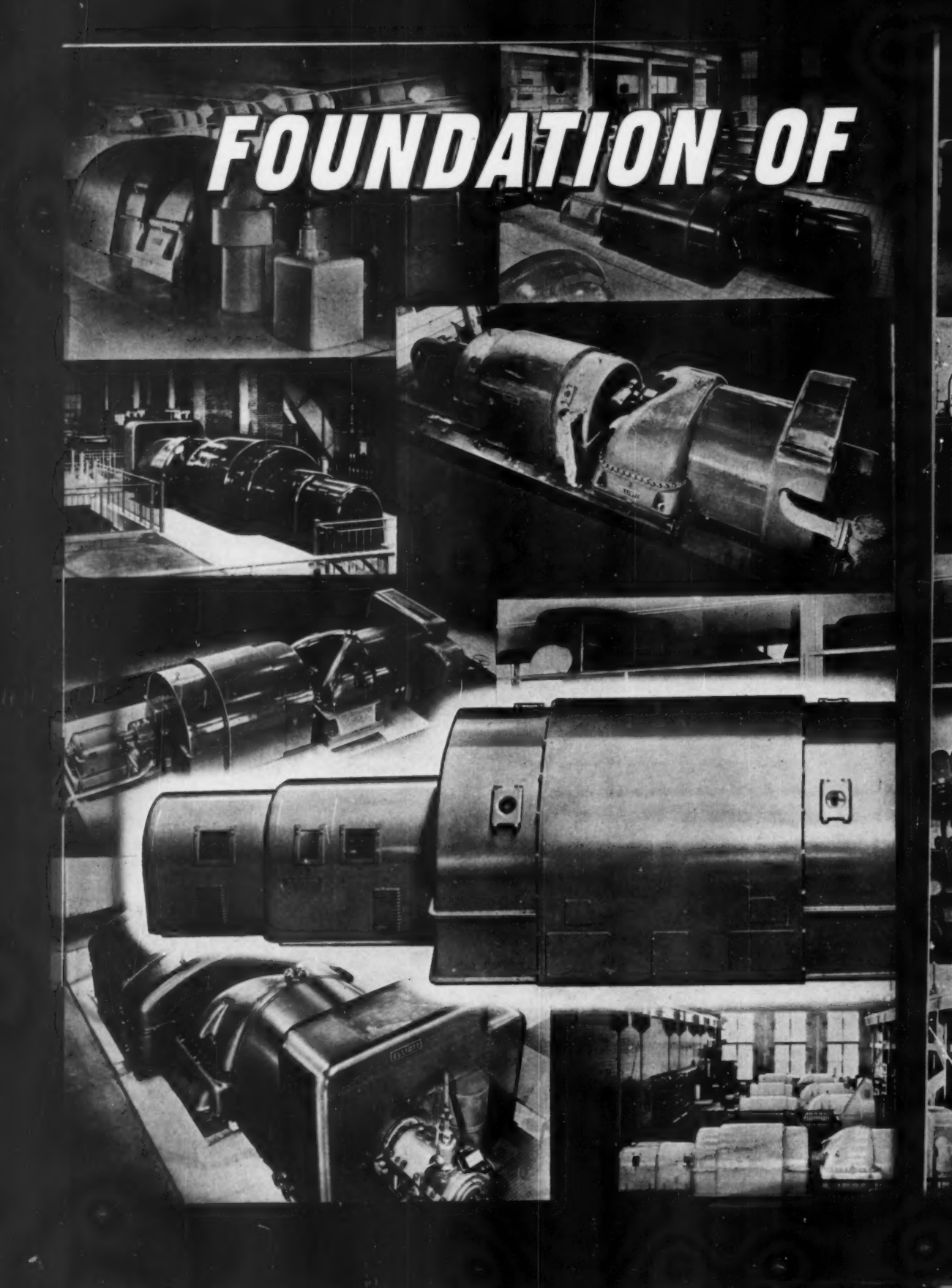
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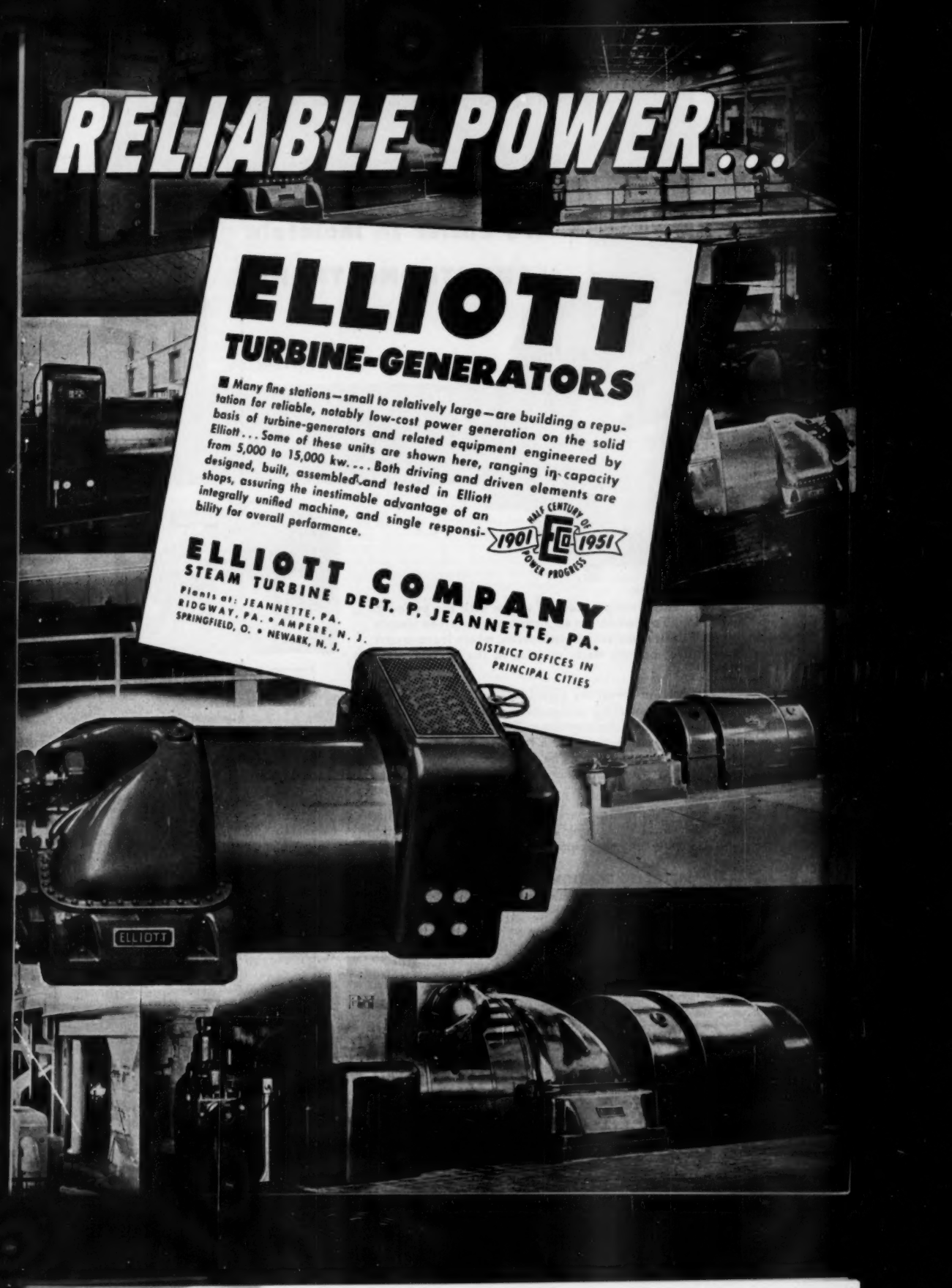
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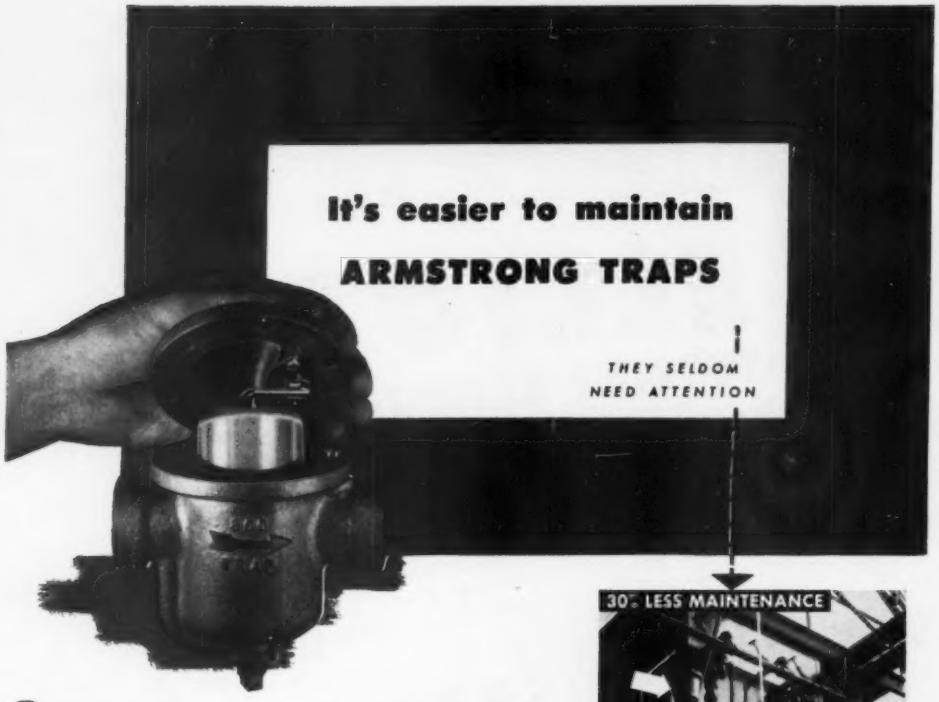

GOOD preventive maintenance of course calls for periodic steam trap inspection. To look inside an Armstrong trap you simply remove the cap and lift out the entire mechanism, which is connected to it. The body full of boiling water remains in the line and need not be handled.

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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May, 1951

VOLUME 55—NUMBER 5

Notes on This Issue

Mobilizing Power Resources

How are you as a power specialist affected by NPA, DEPA, PED?— By DO and MRO orders?—And did you know that on July 1 CMP will supersede DO? If all of this sounds like Greek, you had better read in this issue the lucid interpretation of the functions of existing governmental departments in the mobilization program and how they affect power engineers. Our editors keep in close touch with the shifting Washington scene through frequent personal contact and membership in the Society of Business Magazine Editors, whose Chairman, Paul Wooton, is the Dean of business magazine representatives in the nation's capitol.

A Missouri Team

The Missouri mule is a famous hybrid. The Northeast Missouri Electric Co-op teams up a high pressure steam turbine generator with three large diesel engine generators. The original idea was to install the 15,000 kw steam unit to give the diesels a rest except under peak loads but the way the rural load is growing it looks as though the steam and diesel team will be pulling in double harness.

Working Picture of a Steam Turbine Governor

Here is the clearest explanation of a governor and its workings we have ever seen. There has been a great deal of vague comment written in various places about governors but the operating engineer wants to know *exactly* how a governor functions. The fundamental principles have been used in all sizes, types and makes of governors almost since the first steam turbine. If the engineer understands the complete workings of one governor, he understands them all. This article shows in simple step-by-step diagrams how one function after another is added to the fly-ball mechanism that initiates the control in response to turbine speed changes. Every practical steam engineer will appreciate this material.

Control for a Package Boiler

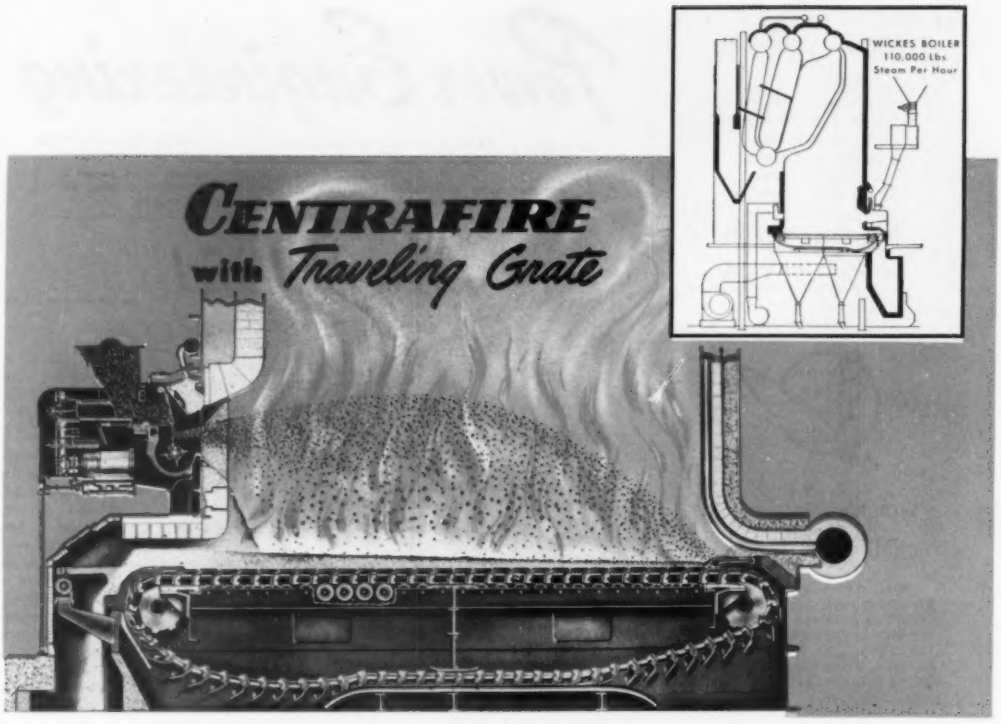
The term "package boiler" is usually applied to the fire-tube type burning oil or gas under complete automatic control; assembled at the factory, shipped as a unit, installed on its own skids and requiring only connection to feedwater supply, electrical circuits and stack. The controls are the part of "package boilers" on which the power or electrical engineer really wants good usable information. This article presents for the first time in publication form the maintenance and operation details of the control equipment written by a very practical electrical maintenance engineer.

Hydrogen-Cooled Machines

While hydrogen cooling improves the efficiency of large rotating electrical machines, particularly turbine generators, it also brings new problems of operation and maintenance. One of these is leakage of hydrogen. First the amount of leakage must be determined, then it must be reduced to a minimum. This article is of direct practical value to every operator of large generating units in utility and industrial power plants. The authors have worked out charts to easily determine the leakage in various sizes of machines and they describe in detail how to reduce the leakage.

Wishful Thinking on the Volga

It is a great temptation to lampoon the propaganda claims of the Soviet Union. If it were merely a matter of friendly rivalry between the Russians and the USA in power development we could indulge in a bit of kidding about their pretentious statements. However, the inaccurate and at times ludicrous propaganda indicate that the Russians really do realize their shortcomings powerwise and are desperately trying to hide them and at the same time build up their facilities. We think it is important that American power engineers be posted on the real picture as nearly as it can be ascertained. This report has been specially prepared for Power Engineering from reports and statements gleaned from inside Russia.



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ENGINEERS' PREVIEW

RIGHT AT THE TIME when more and more private utility companies were realizing the value of allowing the general public, their biggest customers, to visit their power plants and other facilities, as frequently as it could be arranged, security requirements now make it necessary to close many of these plants to visitors. For example, Philadelphia Electric Co. has closed its plant facilities to visitors for this reason. All dams and power plants of the Tennessee Valley Authority are also closed to the public for the duration of the national emergency. Several other utility companies, especially along the eastern coast, have either closed their plants to visitors or will do so in the near future.

★ ★ ★

CONTRACT to furnish 1,200,000-lb-per-hr normal continuous, 1,450,000-lb-per-hr maximum capability pulverized-coal-fired steam generating unit for installation in East River Station of the Consolidated Edison Co. of New York, has been announced by Foster Wheeler Corp.

Unit will be of reheat, dual-circulation type designed to deliver steam at 1850 psi and 1000 F, with 1000 F reheat. Steam temperature will be maintained constant over the range from 500,000 lb per hr to full load.

Achievement of this wide control range is made possible through the use of combination convection and radiant superheaters.

Dual-circulation feature claimed to enable the production of steam of higher purity than attainable in a conventional unit. Steam generator will supply steam to a 160,000-kw turbine.

★ ★ ★

FIRST MODERN, commercial, gasoline-from-coal synthesis plant will start in South Africa within near future, according to The M. W. Kellogg Co. Engineered and built for South African Coal, Oil and Gas Corporation Ltd. Located adjacent to the Vall River, near town of Coalbrook in the Orange Free State, about 40 miles south of Johannesburg. Project is integrated plant, including opening of coal deposits to supply raw material, construction of above-ground gasification facilities to transform coal into synthesis gas; and complete synthesis plant to produce liquid hydrocarbons. In synthesis plant, Kellogg's Synthol process is to be used. Kellogg's recent work has produced radically new type of reactor to handle powdered catalyst as well as new fundamental operating conditions. Plant primarily designed to produce gasoline and Diesel oil in volume. Kellogg will act as over-all project manager of new enterprise.

★ ★ ★

MANUAL OF ASTM Standards on Rrefractories 1951 edition to be published in late spring, will contain additions to group of industrial surveys now contained. New Surveys will include lead industry and survey of refractories used in incinerators. Revisions of ten existing surveys also being completed, including one on malleable iron. Chairman of Committee C-8 on Refractories: R. B. Sosman, Rutgers University, New Brunswick, N. J. Full information from American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

EDITORIAL POSITION OPEN

There is a position open on the Editorial Staff of *Power Engineering* for a qualified Assistant Editor. This is an excellent opportunity for a young man with a technical education who has an interest in technical editing and who wishes a permanent position with a 54-year-old organization. We prefer a man between 25 and 35 years old with a Bachelor's degree in mechanical or electrical engineering, one who has had several years of experience in some branch of the power industry. More important than formal academic technical training or degrees, however, are inherent interest in technical editing and evidences of aptitude for it. If you are interested, write to the Editor, *Power Engineering*, 110 South Dearborn Street, Chicago 3, Illinois.

LARGEST gas turbine-generator yet ordered for the commercial generation of electric power was announced recently by Westinghouse Electric Corp., at South Philadelphia, Pa.

The unit, a 15,000 kw, machine, will be installed in the Bartlesville area of the Public Service Co. of Oklahoma. Natural gas from the Oklahoma fields will provide the heat energy the new turbine will convert into electrical power. It is scheduled for delivery from the Westinghouse Steam Division in about three years.

The gas turbine will drive a hydrogen-cooled generator. The gas turbine will consist of high-and low-pressure turbines driving high- and low-pressure compressors, respectively, with the high-pressure turbine driving the generator. Intercoolers will reduce the temperature of the compressed air between stages of compression, and a regenerator will apply exhaust-gas heat to the air before it enters the combustor, to reduce consumption of fuel. The turbine will operate at inlet temperature of 1350 F. Speed of the turbine will be 3600 rpm.

★ ★ ★

PREPARE yourselves for another scrap drive. Some electric furnace output has already been reduced and open hearth furnaces will be next if the tempo of scrap shipments does not increase soon. If present production trends continue the scrap trouble will be similar to that in the early days of the last war. Industry and government are preparing to make a strong effort to get out more scrap.

★ ★ ★

TO AID YOUNG ENGINEERS in understanding the part that various businesses play in the community, the relation of engineering to business in general and the possibilities of aiding in community activities, a forum is being established in Chicago by the Western Society of Engineers. Gustav Egloff, research engineer, and petroleum technologist of Universal Oil Products Co., is chairman of the general planning committee for this activity. Forum membership is composed of 100 outstanding young engineers sponsored by their respective companies—men who have been out of college not more than 5 to 10 years.

DESTRUCTIVENESS of atomic radiation and A-bomb burns may be decreased through healing power of Aloe Leaf, known to many different civilizations for 3000 years. Today, A-Gic, a gel consisting of 80 per cent pure pulp of this leaf, is being used for healing X-ray burns. Medical reports, clinical records and letters from doctors discuss healing power of this gel in treatment not only of X-ray burns but of fire, household, acid, alkali and industrial burns. Cargille Scientific, Inc., distributor of the product, will make all this information available to all members of medical professions, Civil Defense Officers, public officials and laboratory technicians.

★ ★ ★

BIBLIOGRAPHY of Technical Reports, 13th Volume (January-June 1950) now indexed according to subject. Copies of subject index to Volume 13 may be purchased from Office of Technical Services of the U. S. Department of Commerce, Washington 5, D. C., at $1 per copy. Also available at $1 each are indexes to Volumes 6, 10, 11 and 12. Indexes to Volume 2 and 3 are available at 35 cents each. Check or money order payable to Treasurer of the United States should accompany all orders. Bibliography of Technical Reports, issued monthly, lists additions to 150,000 document files of foreign and domestic reports compiled by OTS. Designed to provide U. S. business firms with highlights of federal and non-confidential technical research.

★ ★ ★

CAN YOU solder glass to metal and make bond stronger than glass itself? General Electric engineers say they can. Method originated by scientists of GE Research Laboratory can also be used to solder metal to ceramics and carbon. Glass and metal areas to be soldered are painted with thin layer of titanium hydride and solder placed on both painted areas. Parts then placed together and heated under vacuum. When temperature reaches about 900 F, titanium hydride decomposes. This causes solder already molten to adhere to titanium-painted areas of both glass and metal forming strong, tight bond on cooling. Possible applications in manufacture of transformers, capacitors and electric motors.

★ ★ ★

ALL ENGINEERS interested in use of ion-exchange resins in treatment of boiler and industrial water should also be interested to learn that new forms of these ion-exchange resins are being used as a very effective weapon against certain bad effects of heart disease. Used principally to relieve dropsy of congestive heart failure. Ion-exchange resins have been used to reduce amount of sodium held in the body, which in turn holds water in tissues, causing dropsy. Very interesting account of this work in article "We've Found a New Weapon Against Heart Disease," by Steven M. Spencer, in recent issue of *Saturday Evening Post*.

★ ★ ★

DEATH on the rooftop is grim story told by files of National Safety Council, covering accidental deaths caused in putting up television antennas all over the country. Amateur handymen account for nearly all deaths, Council said. Television sets first sold included professional installation. In recent months, sets offered with antenna kit for set owner to erect himself. As a result, antennas have been put up without regard to nearby power lines, attached to crumbling chimneys, placed on utility poles carrying high voltage. Most fatalities due to electric shock, although falls of persons unfamiliar with roof top work have added to toll.

EXCELLENT PROGRESS has been made during past year in cleaning up smoke and smog of City of Columbus, Ohio, a project frequently referred to previously in these columns. Of course, the job is not yet completed but progress made is extremely encouraging. For detailed account of what has been done, you might want to get a copy of Annual Report for 1950 of the City of Columbus, Ohio, Department of Public Safety, Division of Smoke Regulation and Inspection. This is under the supervision of Harry C. Ballman, Smoke Regulation Engineer.

★ ★ ★

LAND of black-eyed peas and magnolias, The South, is booming and must now be considered nation's No. 1 region of opportunity. So said Frank F. Groseclose, director of the School of Industrial Engineering, Georgia Institute of Technology, before ASME Spring Meeting on April 4. Once termed country's biggest economic headache, The South, said Col. Groseclose, now shows greater increases percentage-wise in value of manufactured products, valued added by manufacture, and per-capita income during past ten years than U.S. as a whole, while increase in actual annual expendable income in South since 1940 was 357 per cent, greatest in history of nation. Average of 7 new industrial plants opened for business in South every working day for past ten years. For every $1,000,000 that went into new corporations and concerns in the South, $15,000,000 went into expansion of industries already established there.

★ ★ ★

LUMINOUS CAPACITOR may be revolutionary method of producing light. Still in laboratory stage. Apparently transforms electricity directly into light, according to *The Ohmite News*. Light produced by phenomenon known as electro-luminescence, in which certain materials emit light when placed in fluctuating electric field. Device consists of film of phosphor dispersed in dielectric and placed between two conducting plates. One of plates is conducting glass, so light produced can emerge.

★ ★ ★

DR. EDWARD A. UEHLING, 101, oldest living alumnus of Stevens Institute of Technology, graduate of Class of 1877, was among recipients of honor awards for notable achievements in their fields of endeavor, presented by Stevens Alumni Association on February 2, at Hotel Astor, New York. Dr. Uehling is retired president of Uehling Instrument Co., lives at West Allis, Wisconsin. Honor awards also presented to Wilbur H. Armacost, vice president in charge of engineering, Combustion Engineering-Superheater, Inc., New York; and to Dr. Thomas E. Murray, commissioner of U. S. Atomic Energy Commission, formerly president of Metropolitan Engineering Co., Brooklyn. Distinguished service award presented to Dr. Harvey N. Davis, president of Stevens Institute for 23 years, who plans to retire as of September 1951.

★ ★ ★

NEW NON-MELTING WAXES may have wide application. Already successfully used in mechanical packing field. Even if heated to combustion point, these waxes will not melt. Waxes like paraffin, petrolatum, japan wax, beef tallow, beeswax and others have been specially processed to give this extraordinary property. Slightly harder than unprocessed wax, non-melting waxes have higher softening point—but never reach melting stage. Solubility of waxes unaltered. Developed by the Research Div. of the Flexrock Co.

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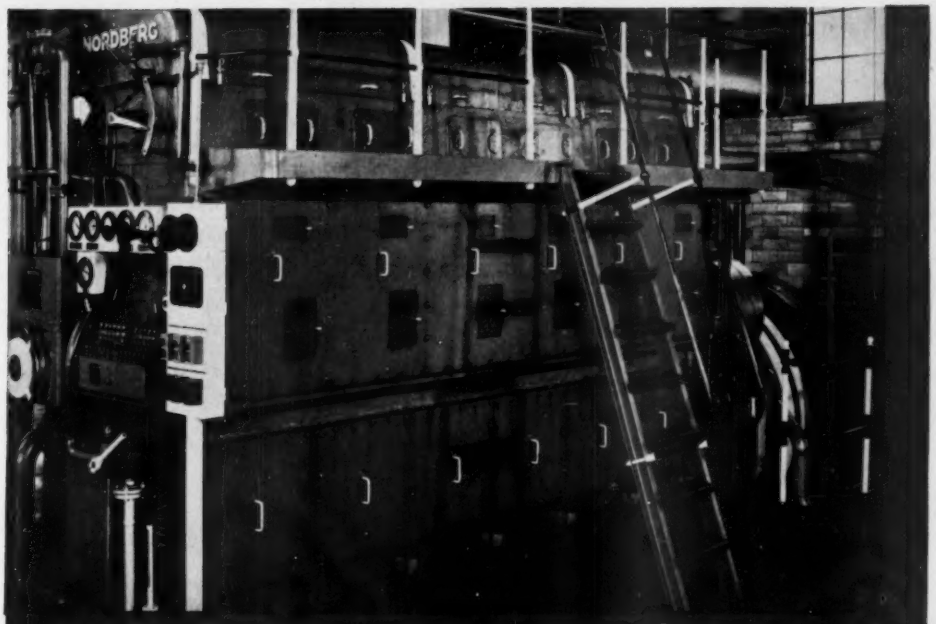

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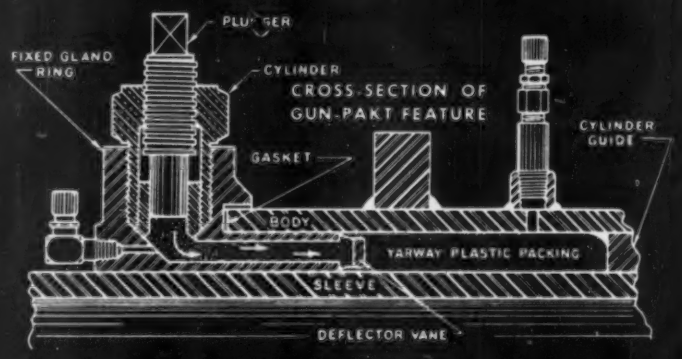

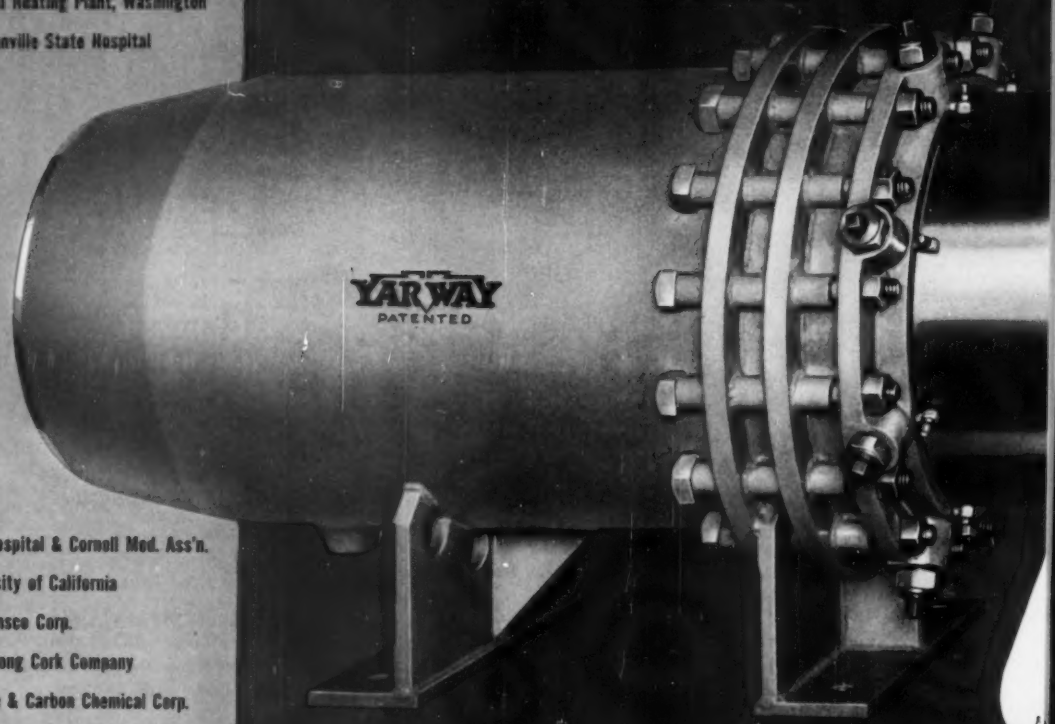

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What feature do you want most in an expansion joint . . . sure movement, simplified installation, ease of servicing, low cost, low upkeep?

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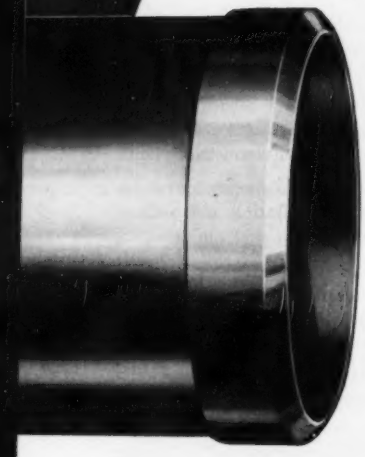
Gun-Pakt Joints are *rugged* joints, strong and dependable. They are *serviced under full steam pressure.* Packing is added simply by inserting a plug of Yarway plastic packing and turning a wrench . . . the joint's tight, the job done.



Yarway Single-end Gun-Pakt Expansion Joint, welding type. Double-end and flanged types also available.

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A glass plant in Ohio . . . a chemical plant in West Virginia . . . a floor covering plant in Delaware . . . plant after plant, representative of virtually every branch of industry, has chosen the C-E Vertical-Unit Boiler, Type VU-10 to meet its particular steam requirements. Here are six important reasons for the VU-10's industry wide acceptance:

Balanced Design – Not one or two features for special needs, but a *completely balanced design* that adapts itself to many conditions. A design in which each element is coordinated with every other for top performance.

Efficient Performance – The VU-10 has high efficiency over a wide range of output, produces steam of satisfactory quality at all ratings and responds to rapid load swings . . . all characteristics of advantage to many industrial plants.

Easy Operation and Maintenance – The VU-10 is simple to operate and maintain – especially advantageous for plants with limited operating and maintenance forces. All parts readily accessible for such cleaning and maintenance work as may be necessary.

Choice of Fuels and Firing – In addition to its wide adaptability, the VU-10 permits you to choose the one *best* method of firing for the fuel and load conditions of *your* plant.

Lower Cost – The standardized balanced design of the Vertical-Unit Boiler effects economies in engineering, fabrication and erection which are passed on to you in lower first cost.

Unified Responsibility – The Vertical-Unit Boiler is a complete unit . . . boiler, furnace setting, fuel-burning equipment, controls, forced draft . . . bringing you the added benefit of one contract, one guarantee and one responsibility.

• • •

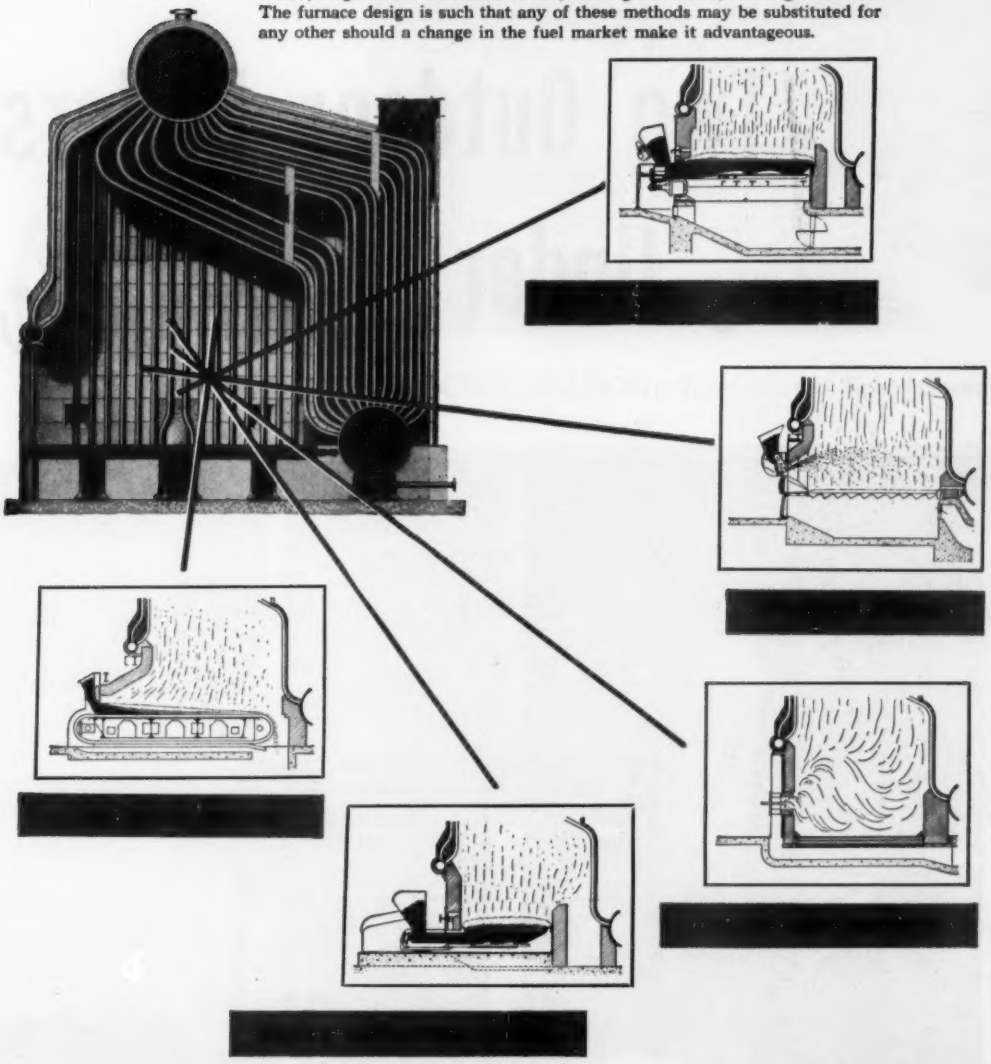
The design, construction and operating features of the VU-10 meet all the requirements of a modern industrial plant. Small wonder so many diverse industries select this unit for their steam needs. If your requirements fall within the capacity range, 10,000 to 60,000 lb of steam per hour, it will pay you to investigate the VU-10. Our engineers will welcome the opportunity to discuss the matter with you or your consultants at your convenience. B-381

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

For every fuel market and every type of load there is *one best* method of firing. The selection of that *one best* method for the fuel and load conditions of a particular plant calls for judgment based on broad experience and free from any incentive to favor one type of equipment over another.

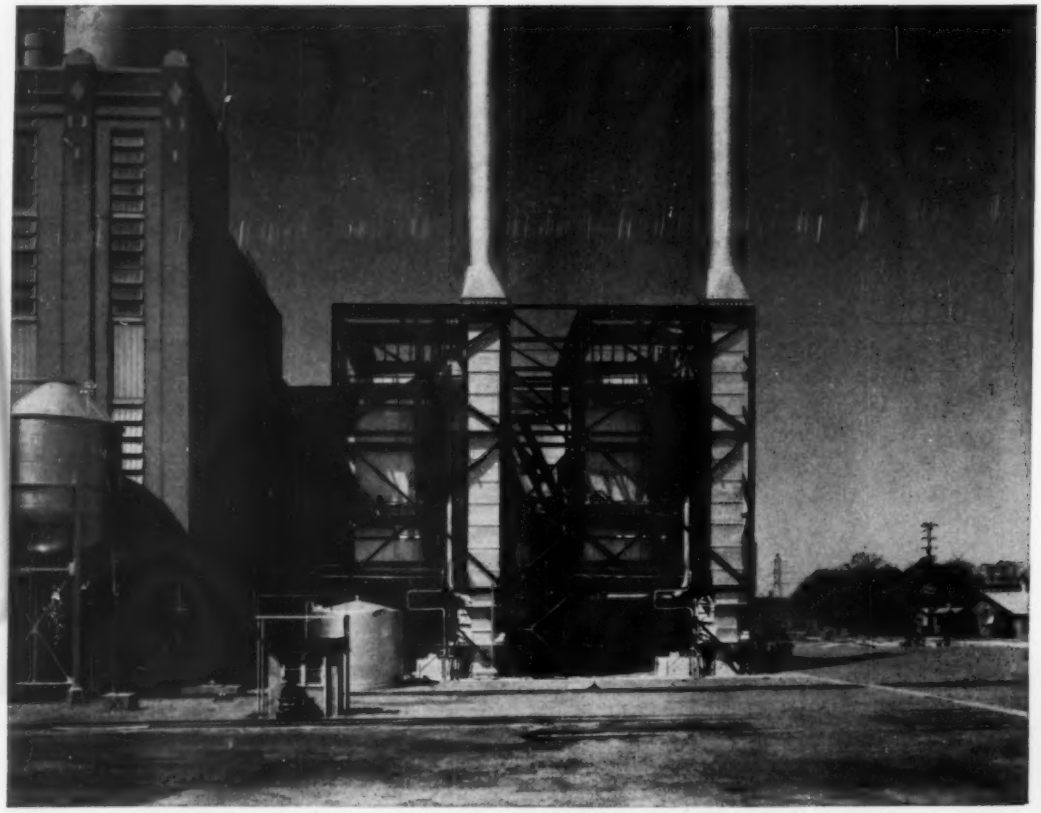
The Type VU-10 Boiler is designed for five methods of firing – spreader stoker, single-retort underfeed stoker, chain grate stoker, oil or gas burners. The furnace design is such that any of these methods may be substituted for any other should a change in the fuel market make it advantageous.



— SUPERHEATER, INC.

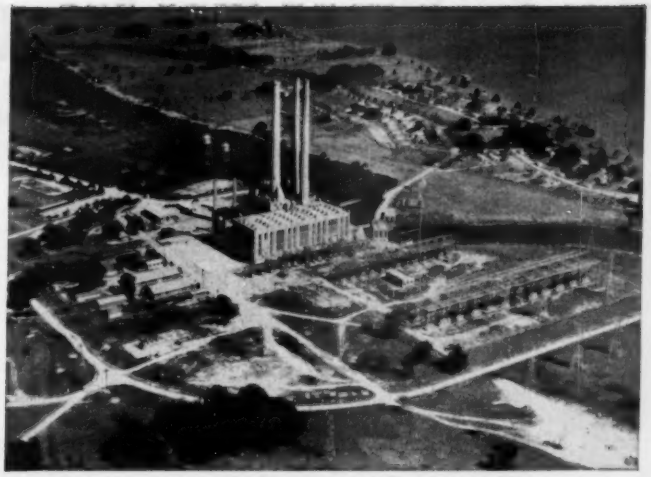
200 MADISON AVENUE, NEW YORK 16, N. Y.

Two Outdoor Boilers Under Automatic



Outdoor Installation of Two Large Boilers at the Trinidad Steam Electric Station.

Aerial View of Trinidad Steam Electric Station. (Note the Two Outdoor Boilers Installed Behind the Main Building).

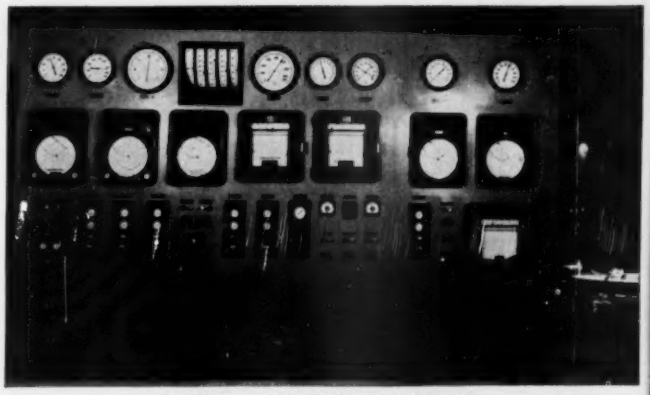


Control

at TRINIDAD STEAM ELECTRIC STATION • Texas Power & Light Company

● A most important part of the Texas Power and Light Company expansion program at their Trinidad Steam Electric Station, is this outdoor installation of two new gas fired, 350,000 lb. per hr. boilers. These boilers, operating at 920 psig., provide 70,000 KW additional capacity to meet the increasing power demand on the Trinidad Station. To achieve maximum efficiency and performance, the boilers were put under completely automatic control.

The AUTOMATIC COMBUSTION CONTROL system and the PRESSURE REDUCING AND DESUPERHEATING STATION were supplied by REPUBLIC FLOW METERS CO.



One Section of the Boiler Control Panels.

A Potent Tool for Cutting Costs

A properly engineered automatic control system is an effective way to cut power costs. Best of all, what automatic control is doing for the large plants such as the Trinidad Steam Electric Station it is also doing for their smaller brothers. But the full benefits can only be realized if the plant designer selects with great care the best control equipment for his job. The control must be carefully matched to the boiler and auxiliary equipment characteristics; it must maintain maximum combustion efficiency under all load conditions.

REPUBLIC CONTROLS are available for all types of load fluctuations, fuel firing, single or multiple fuels, and all types of boilers and auxiliary equipment. Backed by thirty-six years of specialized experience in combustion control, REPUBLIC'S power engineers have developed control systems to answer every type of steam generating problem.

Ruggedly built to outlast the boilers that they serve, REPUBLIC AUTOMATIC CONTROL gives you the best, most economical system engineered to suit your needs.

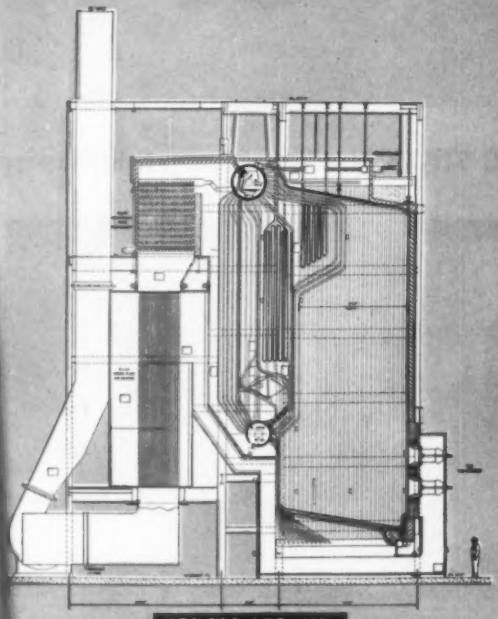
For more information on REPUBLIC AUTOMATIC CONTROL write for Data Book No. S-21 or contact our field engineer nearest you.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

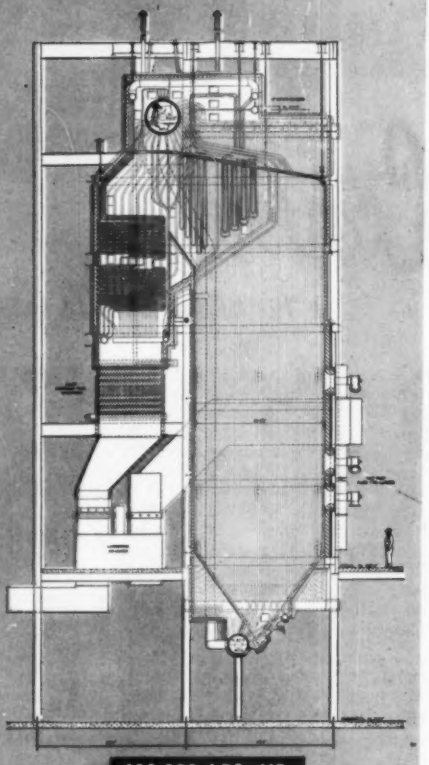
Typical RILEY High Pressure

Here are a few typical layouts of Riley high pressure, high temperature steam generating units. Riley units are establishing enviable records, not only for high efficiency and economy but for long continuous periods of trouble-free operation.

Because of unusual results from existing Riley installations Riley has attained a position among the leaders of the boiler industry. Many purchasers of steam generating and fuel burning equipment have found it pays to ask Riley for a proposal.



450,000 LBS./HR.
1450 LBS.–950°F.



400,000 LBS./HR.
1475 LBS.–955°F.

Dow Chemical Co., Freeport, Texas
The Texas division of Dow Chemical installed their first high pressure Riley units in 1942. They recently ordered four additional units. Ten 300,000 lbs./hr. Riley units are also installed.
Stone & Webster Engineering Co., Engineers

South Carolina Electric & Gas Co., Charleston, S. Carolina
This is the third Riley unit for South Carolina Electric and Gas Co. They installed their first Riley unit in 1947 and their second Riley unit in 1950.
Gilbert Associates, Engineers

TRADE MARK Rx REGISTERED

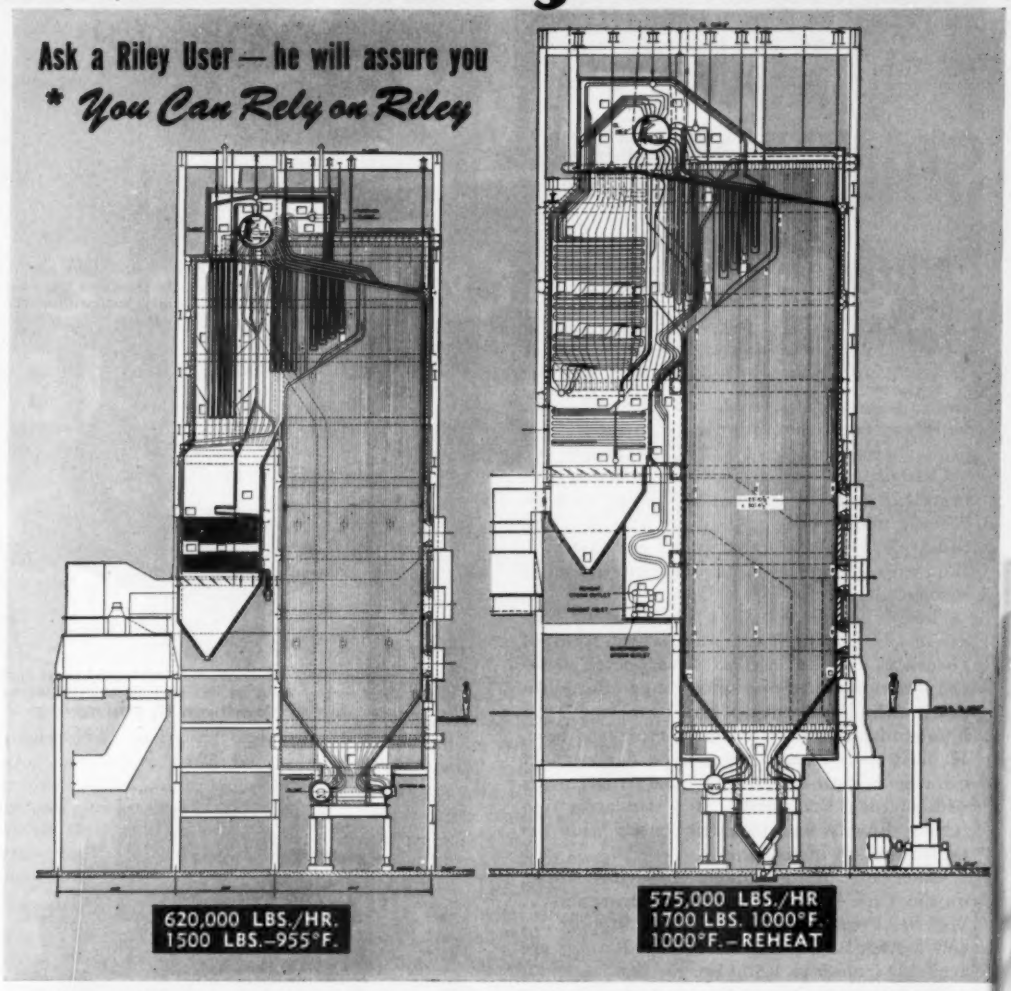
RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston · New York · Philadelphia · Washington · Buffalo · Pittsburgh · Cleveland · Detroit · Chicago
Cincinnati · Atlanta · New Orleans · Memphis · St. Louis · Kansas City · St. Paul · Tulsa · Houston
Denver · Salt Lake City · Los Angeles · Portland · Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

Steam Generating Installations



Utah Power & Light Co., Unit No. 1, Salt Lake City, Utah
For the first unit at their New Jordan Station, Utah Power and Light Co. installed this 620,000 lbs./hr. Riley unit. In 1948 they installed their first Riley unit at their Orem Station.
Bechtel Corp., Engineers

Utah Power & Light Co., Unit No. 2, Salt Lake City, Utah
Utah Power and Light Co. selected this 575,000 lbs./hr. Riley reheat unit as the second unit at Jordan Station. Their subsidiary, Western Colorado Power, also uses a Riley unit at Montrose, Colorado.
Bechtel Corp., Engineers

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly [illegible] costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD [illegible] • AIR HEATERS

NOW STANDARDIZED

3 Precision Controls for All Speed Problems

Here's governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

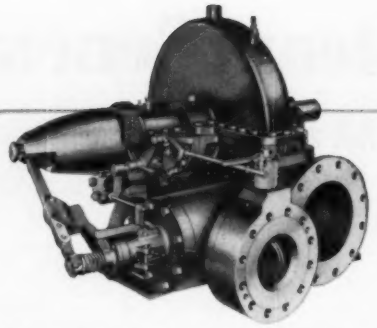
Costly special engineering is eliminated. Advanced design gives an unusual degree of flexibility... with precise speed control for all steam conditions. Results? Initial costs are lower... shipments are quicker... spare-parts inventory is reduced.

Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. All oil-governed, direct-connected Type E units include the standard reservoir-type base, as illustrated. What's more, Type E governors can meet a great number of special requirements with optional accessories. This standardization results directly from Westinghouse's wide experience in all industry.

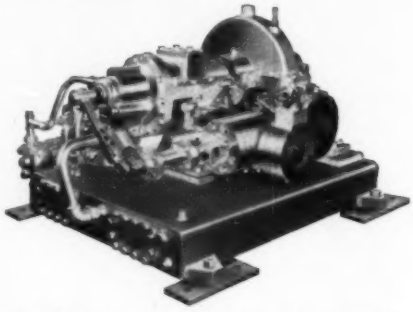
Other outstanding maintenance-saving features on the Type E turbine are Dual Protection... Weather Protection... Centerline Support... and a Rugged Governor Housing. Ratings are available from 5 to 1,500 hp.

For complete information ask your nearby Westinghouse representative for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

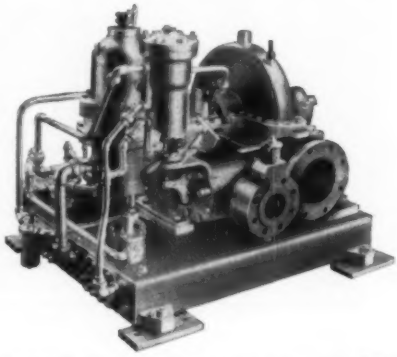
YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines



Shaft-Type Governor. For narrow speed-range applications, this governor automatically positions the steam admission valve to control turbine speed within close limits—*6 to 8% speed regulation.*



Hydraulic-Orifice Governor. For wide speed-range applications such as drives for fans, blowers, and compressors —*3-to-1 speed-adjustment range; 6% speed regulation.*



Vertical Oil-Relay Governor. For narrow-range precision-control applications such as drives for generators, pumps, blowers and compressors—*33⅓% speed-adjustment range; 4% speed regulation.*

I-50527

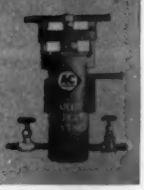
Reduce

Sludge Deposits, Blowdown Losses!

ALLIS-CHALMERS AKON Treatment for Boilers

FREE LIQUID FEEDER

Compact Feeders to AKON Treatment Users BRIQUETTE FEEDER



YOU NEED *Akon* treatment in your powerhouse if your boilers are troubled with sludge deposits, oxygen corrosion, excessive blowdown, or carryover. Allis-Chalmers specialists have been recommending *Akon* materials for such problems for nearly twenty years — and early users still specify *Akon* treatment.

SLUDGE COAGULANT

Akon treatments are primarily sludge conditioners. Sludge is prepared for quick, efficient blowdown — and its prompt, complete removal stops the formation of soft scale before it starts. Suspended sludge, which contributes to carryover, is materially reduced by coagulation.

OXYGEN SCAVENGER

In addition to conditioning the sludge, *Akon* materials remove free oxygen from boiler water to stop corrosion. Even traces of residual oxygen from deaerating heaters can prove troublesome if ignored.

PACKAGE TREATMENT

For plants where water softeners are not used, a combination of *Akon* materials and internal softening chemicals has been briquetted to form a package treatment. Compact and easily handled, *Akon* briquettes carry out the entire softening and sludge conditioning job without the need for elaborate feeding devices.

For the *right* answer to any boiler feedwater problem, contact Allis-Chalmers. (Coupon attached for your convenience.)

Allis-Chalmers
Milwaukee 1, Wisconsin

Gentlemen: Please send me —

☐ Bulletin 2887408 on Akon treatment.

☐ Bulletin 28X6176 on Akon briquettes.

OR . . .

☐ Analyze and make recommendations on my problem, data enclosed.

Name

Title

Company

Address

City State

A-3336

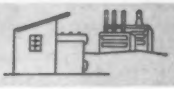
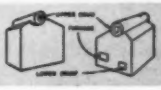
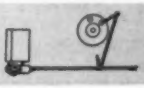
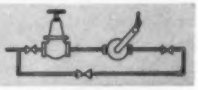
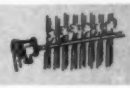
Akon is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

Combined features that distinguish Foster Wheeler package steam generators

WATER TUBE DESIGN	Vertical tubes,...steady water level, closely spaced waterwall tubes on 3½" centers
FACTORY ASSEMBLED STEAM PLANT	Compact, self-contained steam generating units
WIDE RANGE OF CAPACITIES	7,500 to 30,000 lb per hr . . . flexible multi-unit installations for greater capacities
HIGH STEAM TEMPERATURES	Provisions for superheaters in some designs
PORTABILITY	May be transported by common carrier . . . minimizes problems of initial installation and plant relocation
EXPERIENCE	50 years' design, engineering, manufacturing of power plant equipment behind each Foster Wheeler unit
EASILY INSTALLED	Simple foundations . . . few service connections
OUTDOOR INSTALLATION	Rugged, steel encased construction 
ACCESSIBILITY	For inspection,...cleaning, maintenance 
COMBUSTION CONTROLS	Fully or semi-automatic controls for single or multi-unit installations 
CONTROL VALVES	Equipped with 3-valve by-passes 
CLEAN HEATING SURFACES	Soot blowers incorporated . . . cleaning without boiler shutdown 
HEAT LOSS MINIMIZED	Minimum heat loss—from radiation and air infiltration
RAPID LOAD SWINGS	Large diameter drums and ample furnace heating surface

all for the

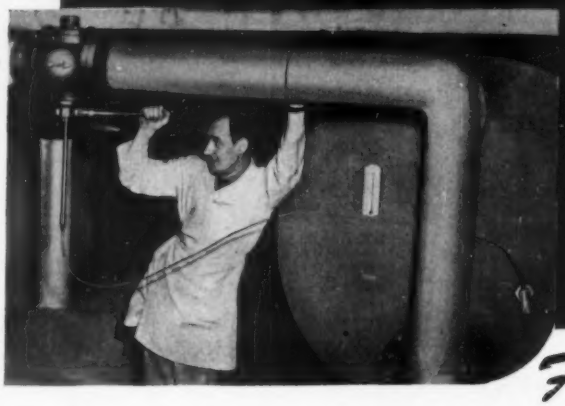
price of a PACKAGE

Your operation deserves a *real* steam plant. Today, mounting orders from large and small companies alike testify to the fact that Foster Wheeler Package Steam Generators are supplying industry's answer to the need for a compact, highly efficient source of steam. These units assure economy in the cost of steam production and high availability. They are easily installed and adapted to various fuel and firing arrangements. The Foster Wheeler Package Steam Generator presents a relatively inexpensive way to modernize your plant.

FOSTER WHEELER

For further information, write FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

Hold Everything!

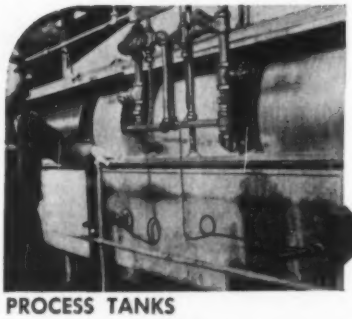


HOT WATER

AT CORRECT TEMPERATURES WITH SARCO **TR-21** REGULATORS

For 20 Years

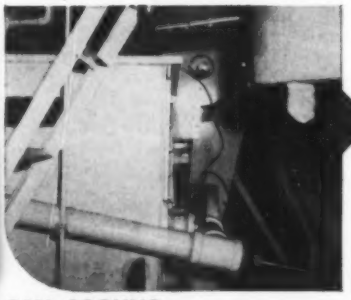
The hot water in this large hotel was held at exactly the right temperature with the Sarco TR-21 regulator illustrated. During all this time there were no complaints because the water was too hot or too cold; and, of course, no heat wasted. Recently a wrench was put on the regulator for the first time and a few dollars worth of new parts installed. Now they look forward to twenty more years of service and saving with Sarco.



PROCESS TANKS

Better Production

No process requires closer regulation than the various tanks in an automatic plating machine. In the plant illustrated, everything is automatic because all temperatures are controlled to within a few degrees by Sarco. The owner reports greatly increased production with practically no rejects and a considerable reduction in the amount of steam used.



CAN COOLING

Production Speed-Ups

Here is a can cooling operation which moves warm cans of fruit through a cooler on a conveyor. When operated by hand, water was wasted to be sure the temperature was safe. Even then, cans sometimes came out too warm and food was wasted. Now, with the same TR-21 regulator shown above, less water is used and no food lost. Ask for Sarco Catalog No. 600.

328

SARCO SAVES STEAM

IMPROVES PRODUCT QUALITY AND OUTPUT

SARCO COMPANY, INC.

Represented in Principal Cities

Empire State Building, New York 1, N. Y.

SARCO CANADA, LTD., TORONTO 8, ONTARIO

...but the greatest marvel of all is its *HEAT!*

It's amazing to think of such things as perfumes, fertilizers, dyes and medicines, coming from a lump of coal.

But it's even more amazing to consider the things that come from a lump of coal when it's put into a firebox . . . and burned! From this one source . . .

. . . Sixteen million homes in the nation get floods of responsive, dependable heat that fortifies them against the hardest winters,

. . . steam is generated that produces over half the electric power distributed by utilities (the same high percentage holds in the newest plants),

. . . heat and power for tens of thousands of commercial, institutional and industrial establishments in the populous eastern area is produced,

. . . twenty-five thousand steam locomotives still on the rails huff and puff and move the nation's freight.

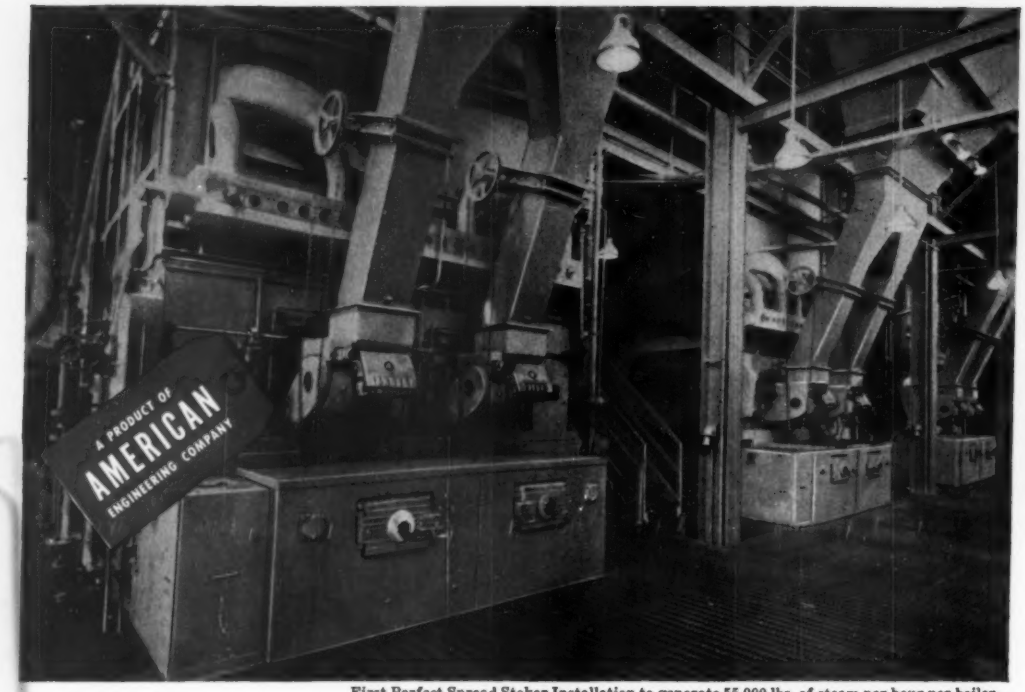
Then, of course, there is the major contribution that coal makes to the manufactured gas industry—a vital utility in many sections.

Coal can be stockpiled more readily than any other fuel. It is less likely to be affected by diversion—created shortages in periods of emergency. Virtually limitless resources eliminate any long-range fear of depletion. Beacon Coal offers added advantages. The fifteen Beacon coals are mined from fields famous for quality. Each offers desirable special properties that plus its performance. We'll be glad to talk to you about supplying your requirements.

EASTERN GAS AND FUEL ASSOCIATES
BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

1... 2... and now a 3rd order for



First Perfect Spread Stoker Installation to generate 55,000 lbs. of steam per hour per boiler.

Day and night, for weeks at a time, Spreader Stoker continuously releases 700,000 B.T.U. per hour per square foot of active grate area

1 IN THE FALL of 1949 a very well known corporation installed three AE Perfect Spread Stokers to generate 55,000 lbs. of steam per hour each in one of its midwest plants.

2 Months later the Company needed more steam from larger boilers in another plant where the existing stokers had been designed to burn 12,300 B.T.U. per pound coal. Over the years, however, the available coal dropped to as low as 9500 B.T.U. per pound so the plant could not carry the required load.

On the basis of proved performance, an AE Perfect Spread Stoker was installed as a replacement...and here's the record:

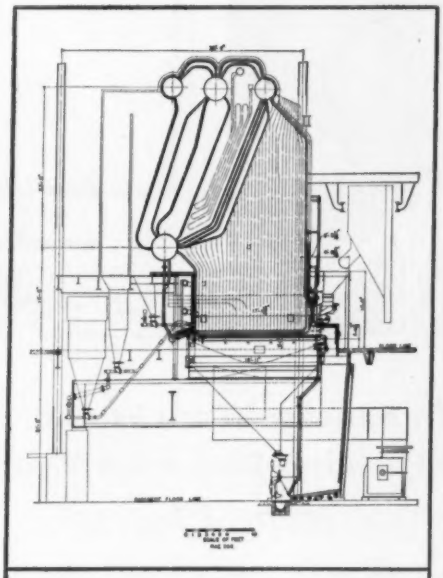
The Perfect Spread has averaged better than 180,000 lbs. of steam per hour—24 hours a day—7 days a week for weeks on end. Efficiency is about 84% and the release rate exceeds 700,000 B.T.U. per sq. ft. of active grate area per hour! In terms of sustained results per sq. ft. of grate surface this is probably the highest duty spreader stoker installation in the world. With an increased manufacturing load they now find they can carry 900,000 lbs. per hour.

3 And now, again on the basis of performance, the same company has ordered two more duplicate Perfect Spread Stokers.*

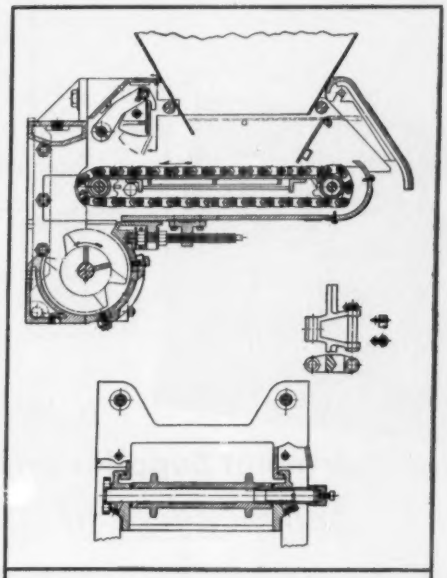
AE Perfect Spread Stokers burn high and low ash coals with practically equal efficiency. They assure positive, continuous coal feed and unbe-

***AS THIS MESSAGE WAS GOING TO PRESS, THE ABOVE COMPANY PLACED A FOURTH ORDER FOR A PERFECT SPREAD STOKER.**

PERFECT SPREAD STOKERS



Second larger installation of Perfect Spread Stoker actually giving 200,000 lbs. of steam per hour from a single boiler.



NON-CLOGGING CONVEYOR FEEDER: Coal enters feeder from hopper, and is conveyed positively, continuously and uniformly forward. Coal is not fed in slugs.

lieveably even distribution. *They never clog on wet coal.*

Perfect Spread Stokers have a capacity range from 8,000 to 500,000 lbs. of steam per hour... coal feeders are adjustable from 50 lbs. to 7500 lbs. of coal per hour. Mail coupon today for a copy of the Perfect Spread Stoker booklet and for a reprint of a new report on large spreader stokers. Also, if you are now considering a boiler in capacities from 300,000 to 500,000 lbs. of steam per hour, let's arrange to get together and discuss cross-firing.

WON'T CLOG ON WET COAL

AMERICAN ENGINEERING
COMPANY
PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2408 Aramingo Avenue
Philadelphia 25, Penna.

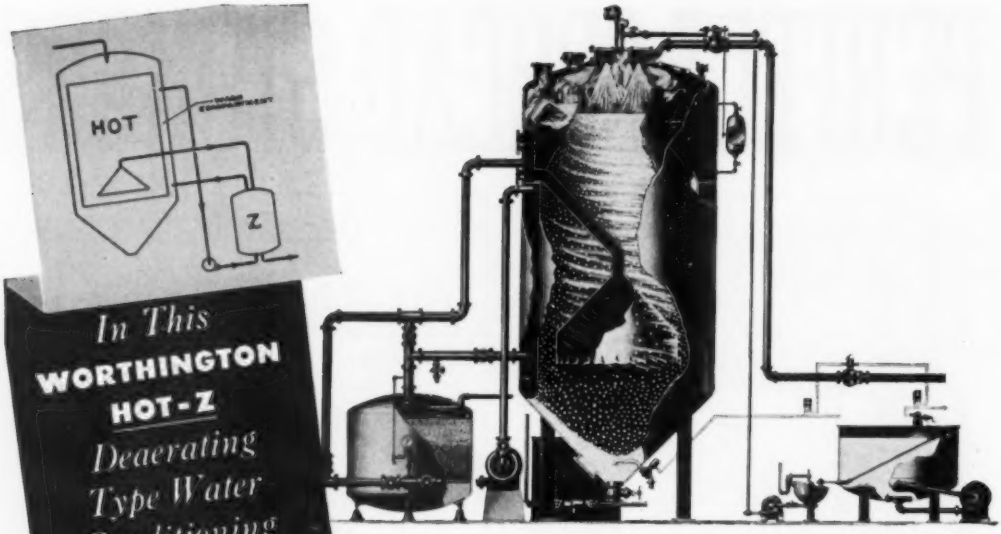
Gentlemen: Kindly send me free copy of Perfect Spread Stoker booklet and new stoker report ☐. I should like to discuss cross-firing ☐.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State____



In This
WORTHINGTON
HOT-Z
Deaerating Type Water Conditioning System . . .

Built-In Annular Wash Water Compartment Supplies and Reclaims Backwash Water

Independent of the Softening Process

No other Hot Zeolite System offers you so many advantages as this Worthington Hot-Z System. A quick review of the vital facts will show you why.

As you probably know, Hot Zeolite beds require periodic expansion to minimize packing and friction loss, and to insure efficient contact of each Zeolite particle with its share of dissolved impurities. This need for bed expansion occurs not only during the regeneration routine, but also several times during the period between regeneration routines. That's why it is important for you to use clean, softened water, preferably at normal operating temperature, for the reverse flow or "backwash" operation.

Worthington does it!

The Worthington Standard Hot-Z System with its backwash feature provides a built-in annular wash water compartment that supplies and reclaims backwash water . . independent of the system's softening process. In this compartment, backwash water is cleaned and maintained at normal operating temperature.

This backwash feature pays off particularly in systems employing filters because it *makes filter beds last as long as eight years.*

Other advantages

Worthington Hot Process Systems come equipped with modern, direct contact vent condensers. This means, no more of the scaling trouble that made the old-fashioned shell and tube types such a nuisance.

In addition, Worthington Hot-Z Systems operate on low-priced lime and salt. That's why the average installation saves enough in chemical costs to pay for itself in 3 years.

Get all the facts!

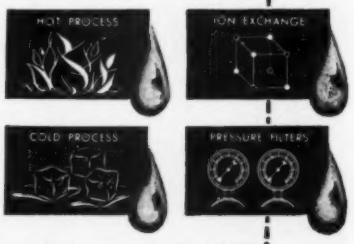
It will pay you to investigate the Worthington Hot-Z System thoroughly. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find in our Hot-Z System, as in so much other equipment, *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Section, Dunellen, N. J.*

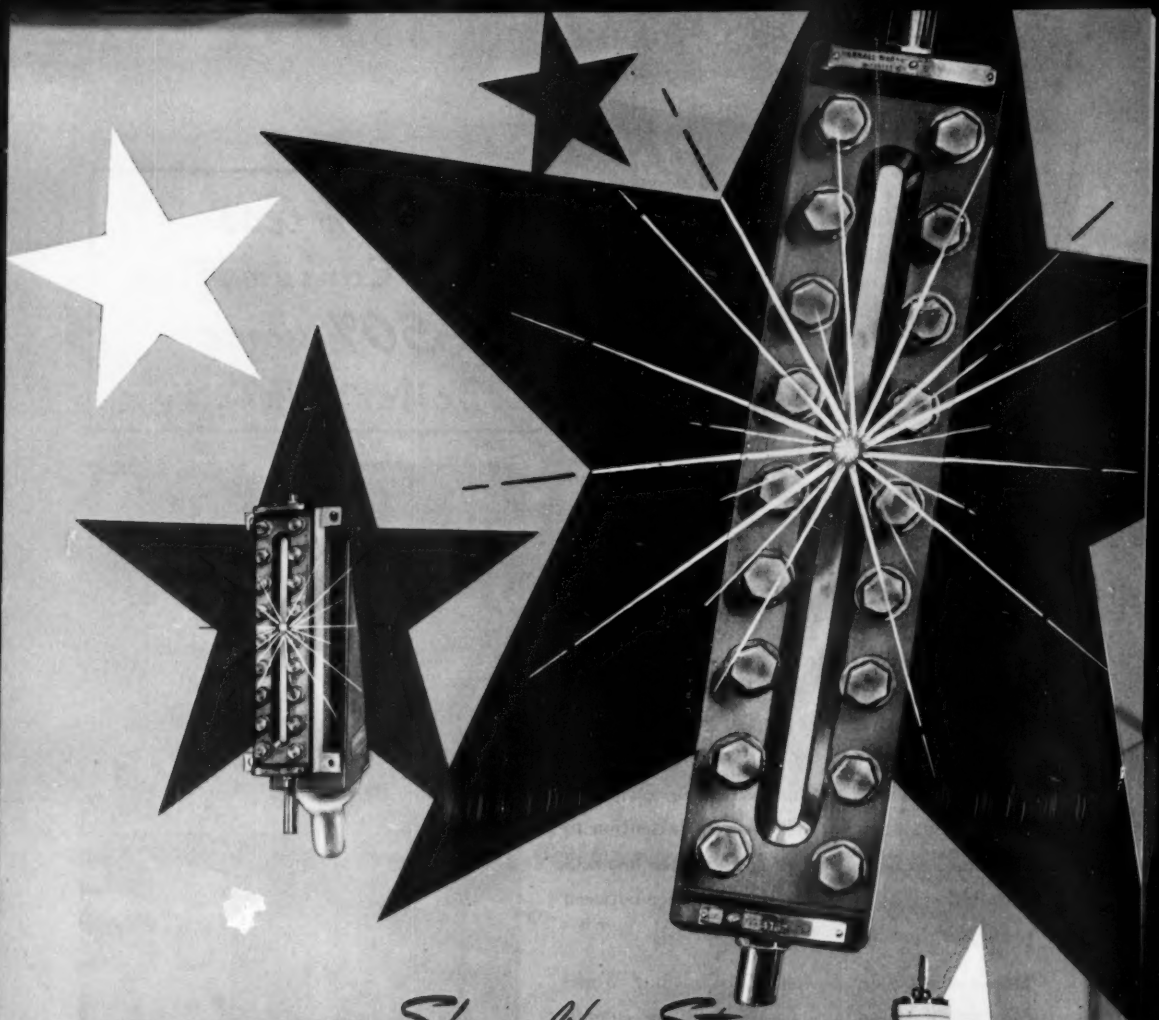
JI-1

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems





BOILER WATER LEVEL *Shines like a Star*

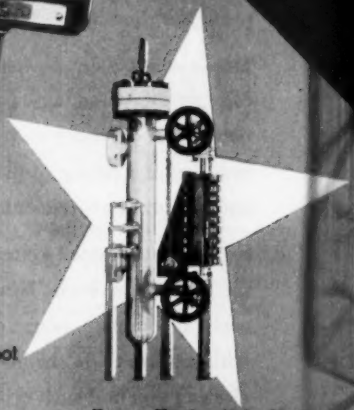
WITH YARWAY TYPE "M" ILLUMINATOR

Now you can *really* see that boiler water level.

Extraneous light, dust particles in the air, deposits on the gage glass—none of these stop the superior penetration of the blue-white light from the Yarway Type "M" Illuminator. It makes the meniscus at water level *stand out like a brilliant star.*

The Type "M" Illuminator is designed to give maximum brilliance, and spot the water level over its entire traverse. It's effective over longer distances.

Equip new or installed Yarway Flat Glass Gages with the Type "M" Illuminator for a new high in easy gage reading. For specifications and prices call your nearest Yarway office or write . . .



Yarway Floatless Hi-Lo Alarm Water Column with Vertical Pressure-Sealed Flat Glass Gage. Equipped with Type "M" Illuminator. For pressures to 2500 psi. See Bulletin WG-1811.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

STEAM PLANT EQUIPMENT * * * **YARWAY**

Could You Use SAVINGS *Like These?*

40% less
Fuel Consumption
50% more
Boiler Capacity

Bailey Meters and Controls Insure Savings at Kerr Bleaching & Finishing Works, Concord, N. C.

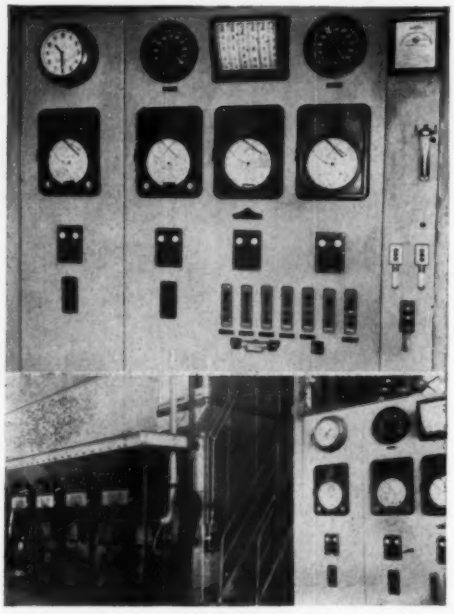
The key to complete returns on any investment in new power equipment is a fully co-ordinated system of meters and controls. It's the old story, the tail that wags the dog—careful attention to this comparatively minor part of the over-all installation cost can mean the difference between profit and loss in operation.

Here's where Kerr Bleaching & Finishing Works has cut operating costs—by installing *co-ordinated* Bailey Meters and Controls. The installation includes Bailey Meter Combustion Control, and Bailey Two-element Feed Water Control.

Such a co-ordinated system is an important plus for Bailey customers. Nowhere else can you buy such a complete range of equipment, selected without bias to do the best job for you. Nowhere else can you find such expert engineering service, immediately available through conveniently located direct sales and service representation. May we help you?

Call our local branch office or write for Bulletin 15-H.

A-113



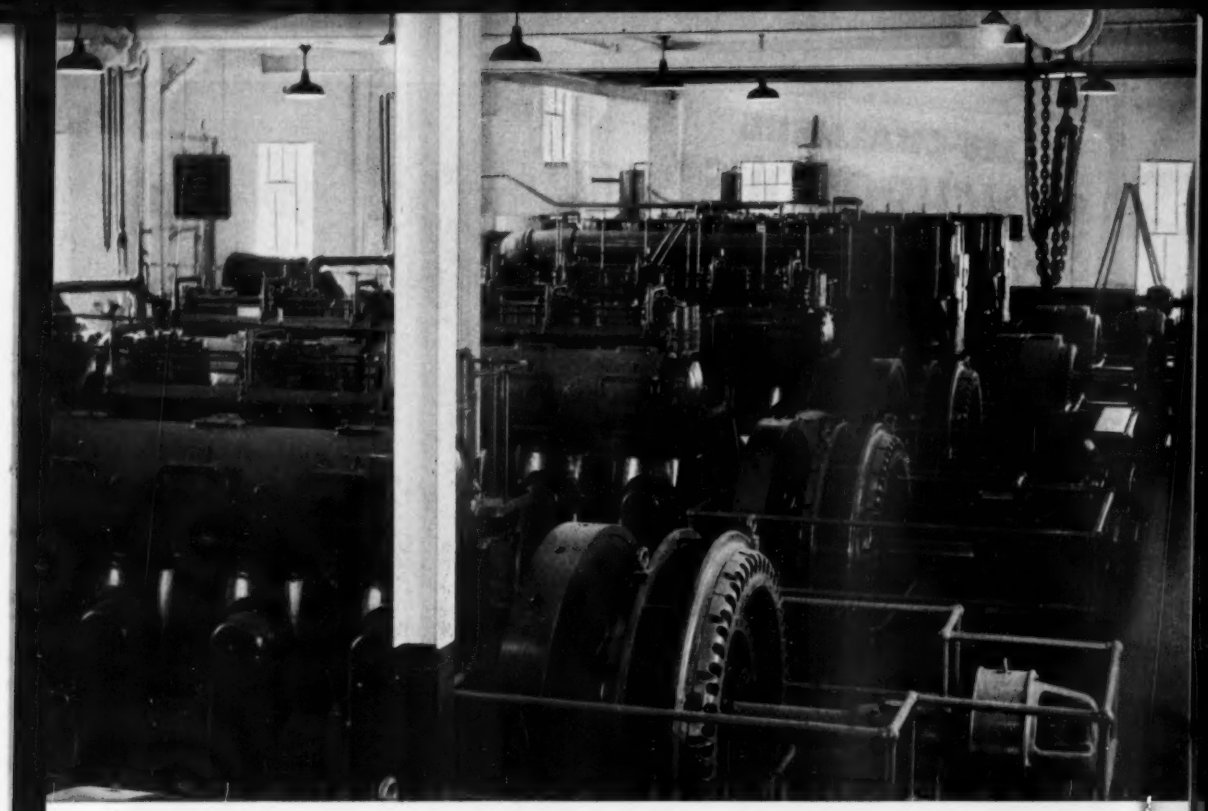
Control panel, showing completely co-ordinated Bailey Meters and Controls at Kerr Bleaching and Finishing Works, Concord, N. C.

BAILEY METER COMPANY

BAILEY METERS

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS



Port carbon, bearing failures, and ring sticking cut to a minimum with...

STANDARD HD
TRADE MARK
Diesel Oil

● Stuck rings plagued the Glidden (Iowa) Rural Electrical Co-operative. Overhauls for the plant's seven diesel engines were necessary every 3,000 to 4,000 hours. Moreover, port carbon had to be removed every 300 hours from some engines. Bearing failures added to the troubles.

But that was all changed, in 1947, when a switch was made to STANDARD HD Diesel Oil.

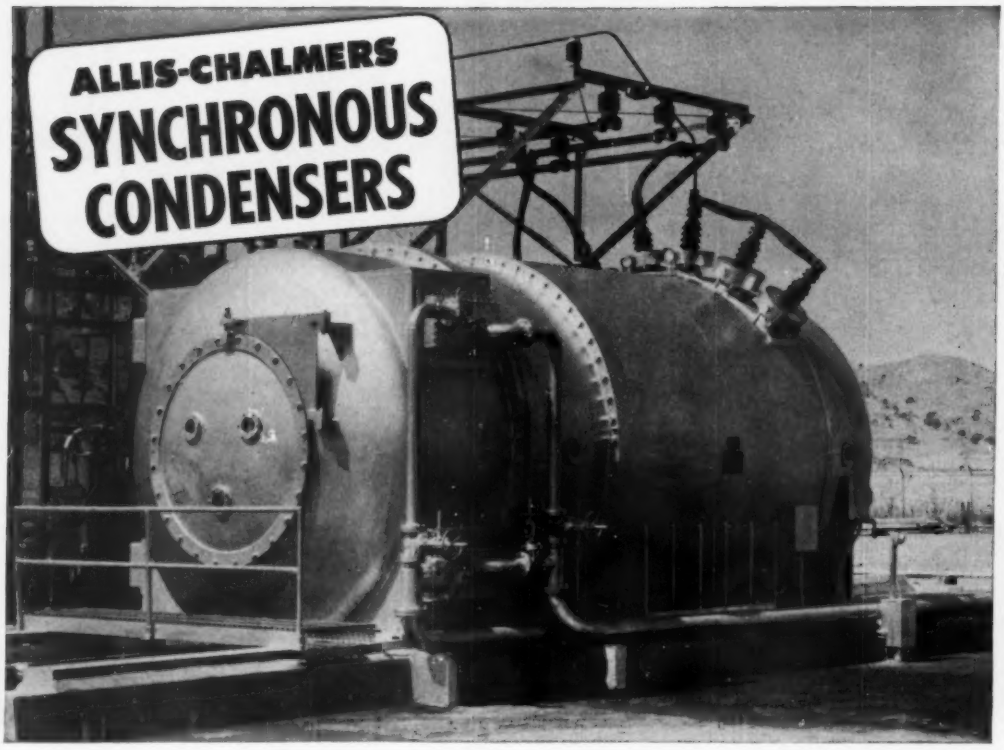
Ring sticking troubles have been eliminated. The first diesel to use STANDARD HD has now operated 15,000 hours without overhaul and shows no sign of requiring one. Carbon formation has been reduced to the point where it is only necessary to clean ports every 600 hours instead of every 300 hours. Bearing maintenance has ceased to be a problem.

The experience of this diesel operator indicates how STANDARD HD Diesel Oil will help you eliminate costly maintenance and operating problems. A Standard Oil lubrication specialist can show you many plants where STANDARD HD gives this cost-reducing performance.

• • •

Call the nearest Standard Oil Company (Indiana) office, or write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the services of a lubrication specialist.

STANDARD OIL COMPANY (INDIANA) STANDARD



Southern California Edison Stabilizes Transmission System

With Allis-Chalmers Hydrogen-Cooled Synchronous Condenser

THIS 40,000/16,800 KVA HYDROGEN-COOLED SYNCHRONOUS CONDENSER supplies reactive kva to regulate voltage and stabilize the far-flung transmission lines of Southern California Edison. It is one of several similar Allis-Chalmers machines built and building for large power systems with relatively long transmission lines. All are custom built to fill system requirements and incorporate proven Allis-Chalmers features which assure long service life and low operating cost.

Whatever problem you may have in electrical power generation, distribution, control or regulation, your Allis-Chalmers representative can help you. For further information on Allis-Chalmers synchronous condensers, write Allis-Chalmers, Milwaukee 1, Wis., and ask for Bulletin 05B7285. A-3345

ALLIS-CHALMERS

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can't be harmed by ozone or dampness

USKORONA Ssplicing compound
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30 FT. ROLL
OZONE AND MOISTURE RESISTING COMPOUND
Uskorona combines maximum resistance to OZONE and MOISTURE with high tensile strength, elongation and dielectric resistance. Fuses quickly without heat or pressure and makes PERFECT SPLICES.
MADE IN U.S.A.
United States Rubber Company

United States Rubber Company research engineers developed USKORONA to eliminate the problem of corona (ozone) deterioration.

Today USKORONA is the only tape that is both moisture and ozone resistant. In a test of four of the leading brands, USKORONA was the only tape to withstand the 4-hour corona exposure. To be extra sure, USKORONA was exposed for 500 more consecutive hours and still showed no signs of corona deterioration.

With such evidence, no wonder USKORONA is used by leading power companies for splices, joints and other underground connections. For more information about moisture and ozone resistant USKORONA, write to the...

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UNITED STATES RUBBER COMPANY

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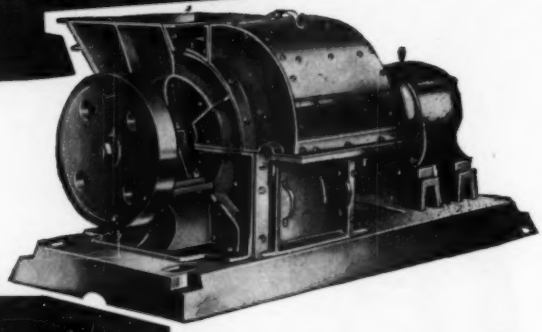
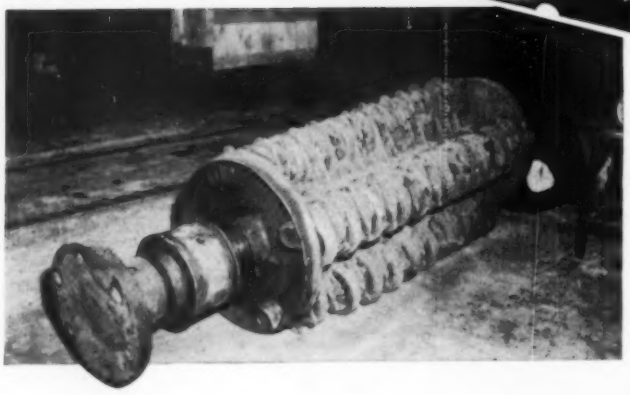




23 Year Old AMERICAN CRUSHER Now Ready For New Career

Far from being ready for retirement, the 23-year-old American Crusher, whose rotor is shown here, was recently overhauled and transferred to its new home at the Arkwright Mine in Morgantown, West Virginia—where it is now prepared to start a new and productive life.

PATENTED MANGANESE STEEL SHREDDER RINGS

Since 1937 this mechanical "old faithful" has reached over 2½ million tons of 6-inch lump to minus ¾ inch screening—at a total parts-replacement cost of only $.0007 per ton (including the recent reinstallation costs).

Only such features as the exclusive, patented Shredder Ring—originated and perfected by American—could produce such long-lived, economical performance as shown in this typical case history. When you plan to purchase a coal crusher, plan to investigate the built-to-produce American Rolling Ring Crusher.

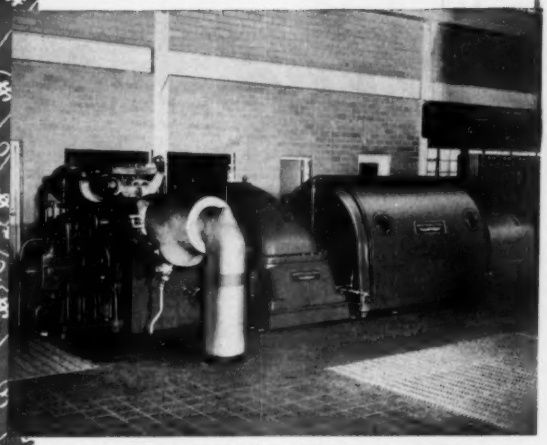
WRITE for Bulletin "CRUSHING COAL AT LESS THAN 1¢ PER TON"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1431 MACKLIND AVE.
ST. LOUIS 10, MO.

FACTS ABOUT THE *Most Profitable Turbine Generator Investment* YOU CAN MAKE...



One of two Worthington 4000 kw turbine generator sets installed in a mid-western municipal power plant, operating on 600 #G and 750 F.T.T. Steam exhausting to 28" Hg vacuum.

Worthington's Experience and Undivided Responsibility Assure Low Cost, Dependable Power

Builders of steam turbines for over 30 years, Worthington's Steam Turbine Division is backed by the experience and resources of the entire Worthington organization — recognized leaders in the power plant field for more than a century. In view of today's increased turbine pressures and temperatures — and the resulting needs for new and special materials — this vast, combined source of technical knowledge has proved of tremendous practical value in developing turbine design, construction and performance.

Generators Are Worthington's, Too

The generators used with Worthington Turbines are built by a Worthington subsidiary that has specialized in this field for over 45 years. This means that Worthington, as manufacturers of *complete* turbine generator units, assumes *undivided responsibility* for the coordinated design, assembly and performance of these units.

Before shipment, Worthington Turbines and Generators are assembled together *as units* for testing and adjustment — eliminating the necessity for doing this after installation. Also, for installation and service, Worthington turbine specialists and regular Worthington service men are always available from our District Offices throughout the country.

Check These Over!

Adding up, Worthington's matchless power plant experience . . . huge manufacturing facilities . . . long specialization in both turbine and generator manufacture . . . undivided unit responsibility . . . and skilled technical service . . . are the best assurance you can get anywhere of efficient, economical steam turbine power.

Worthington makes turbines in a wide range of sizes and types, each one designed to make steam do more work. For details proving *there's more worth in Worthington*, contact your nearest Worthington representative. Or write to *Worthington Pump and Machinery Corp., Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

STEAM TURBINES

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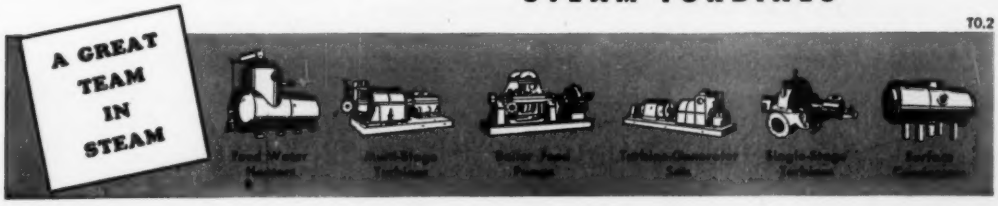

Nalco

Route to Your Plant Process Engineers:

BOILER WATER (AND PROCESS) ANTIFOAMS

☆ **CLEAN STEAM** results when you use Nalco Antifoams . . . No carry-over . . . No scaling of traps or valves.

☆ **LESS BLOWDOWN** with Nalco Antifoams because much higher dissolved solids concentration can be safely carried.

☆ **PROCESS USES** of Nalco Antifoams are saving time, trouble, money in more and more plants . . . Do your Process Engineers a favor by passing this ad on to them—Nalco Antifoams react in much the same way in many process liquids as they do in boiler water!

Nalco Antifoams are the chemicals which can bring you this modern economy. They are fed directly into feedwater or boilers with other water treatment compounds, or independently, in dosages of *only 5 to 8 parts per million!*

The use of Nalco Antifoams has consistently enabled boiler operators to double, triple or even quadruple previous concentration limits . . . and at the same time produce cleaner steam.

Tests in an operating 70,000 lb./hr. boiler (see water analysis below), with 8 p.p.m. Nalco antifoam, failed to produce carryover when dissolved solids concentration *exceeded 25,000 p.p.m.!*

If your antifoam performance is less than you can get with Nalco Antifoams, act now to cut operating costs.

TEST BOILER WATER ANALYSIS at beginning of no-blowdown run, in p.p.m.: H-O, P-720, M.O.-750, Cl-900, SO_4-1420, PO_4-40, DS-3350, S.S.-Trace.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place
Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario.

THE *Nalco* SYSTEM

Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

WATER CONDITIONING

101 Treating Sulfide Contaminated Water—A practical and low-cost method of removing malodorous sulfides from water supplies by means of company's Amberlite IRA-410 which, when operated in the chloride cycle, will effectively remove and replace sulfides with chloride ions is presented in 8-pp Form 2025. It discusses operating procedure, properties of this amine-type anion-exchanger, regeneration, simultaneous softening and sulfide removal. Includes graphs showing effect of influent composition on sulfide capacity and sulfide capacities at pH 7.0. Resinous Products Div., Rohm & Haas Co.

102 To Control Slime in Cooling Water—Technical Bulletin B-76, 5 pp, covers Santophen 45, a technical grade of sodium trichlorophenate for controlling the formation of slime in industrial cooling waters and now available in experimental quantities. Gives detailed information on chemical and physical properties, plus test data and suggestions for use. Organic Chemicals Div., Monsanto Chemical Co.

103 Zeolite Softeners—Publication 4620, 32 pp, gives a detailed explanation of the sodium zeolite softening process, defining terminology used and providing data necessary for laying out a zeolite water softening plant. Tells factors governing sizing of such equipment, selection of zeolite material and describing both siliceous and non-siliceous zeolites and the four steps of operation of a zeolite softener. Explains design and function of company's Hydromatic control valve, incorporated in these softeners. Accessories, regenerating equipment, and details of automatic operation are also covered. Cochrane Corp.

104 Silica Removal—"Zero Hardness by Amberlite Deionization" is a 4-pp folder designed to help power engineers evaluate the usefulness, applications and recommended layout of ion exchange systems to provide water free from hardness, carbon dioxide and silica. Text explains results to be expected from both single-bed and multiple-bed systems. Case histories, illustrated by block diagrams, are presented showing results attained in deionization by various systems. Resinous Products Div., Rohm & Haas Co.

INSTRUMENTS AND CONTROLS

105 Inclined Draft and Vertical Tube Gages—Newly published Bulletin 102, 16 pp, describes portable, stationary and laboratory-type inclined draft gages and accessories. Instructions for securing readings in conjunction with company's pitot tubes are given, as well as suggestions for use of the draft gage. Tables and other useful data are included. Ellison Draft Gage Co., Inc.

106 Control Equipment—Catalog 51, company's newest publication on steam and liquid control equipment, is a more complete, improved book containing 96 pp of illustrations and engineering data. Covers precision pressure regulators, temperature regulators, float valves, water gages, float boxes, safety and relief valves, strainers. Drawings, layout diagrams, dimensions and capacity tables are included. G. O. Keckley Co.

107 Packaged Control—Six-pp Bulletin AV-300 illustrates and describes manufacturer's Electrosire valve, a packaged air control unit consisting of four-way directional valve, solenoid controls, and independent speed regulators for control of piston rod speed of air cylinders in either or both directions. Detailed technical data and wiring diagrams. The Bellows Co.

108 Combustion Controls—Catalog CPE, 12 pp, provides latest information, specifications and photos of manufacturer's combustion instruments and controls. In addition to widely used electric damper controls and gages, booklet describes a new master regulator for automatic regulation of steam pressure on any type of stoker-, gas-, or oil-fired boiler and designed for use with an electric drive unit to provide automatic proportioning of fuel and air feed, according to requirements. Cleveland Fuel Equipment Co.

VALVES

109 Non-Return Valve—Six-pp Bulletin S-3, describing a cushioned single-acting non-return valve, shows in detailed drawings the three different yoke assemblies on elbow, angle and globe bodies. The adaptability, testing, construction, installation, sequence of operation, servicing and specifications are discussed. Tables of dimensions, shipping weights, materials are included. Golden-Anderson Valve Specialty Co.

110 Handbook on Manual Valves—More than 80 pp of engineering data on manual valves for pressures to 6000 psi contained in Catalog 1-B1. Covers entire range of Company's shut-off, Selector and Manipulator valves. Explains and illustrates Shear-Seal principles, a pressure balanced self-aligning tubular valve seat which maintains intimate contact with an optically flat porting disc by which flow passages are opened or closed. Catalog includes outline for determining proper valve size with tables giving steel pipe data and capacities of hydraulic rams. Barksdale Valves.

111 Valve Price List—Besides giving 1951 prices this 8-pp booklet contains information on sizes, and materials of construction for company's line of valves. Covers bronze valves and cocks, iron valves and cocks, iron and brass unions, expansion and swing joints. Jarecki Valve Div., H. K. Porter Co., Inc.

112 Welding End Specifications—Vol. 11, No. 36 of Valve Values, company's service publication, contains a table of welding end specifications for cast steel valves, developed from specifications of American Steel flange standard B16a of 1939, ASA B31.1 1951 Code for Pressure Piping, ASME

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Power Boiler Code for 1946 and Pipe Fabrication Institute Standard ESI 1946. The table is removable for desk top reference. Includes standard dimensions of welding ends, diagrams of straight bevels for pipe wall thicknesses of ¾ in. or less and diagrams of U-bevels for pipe wall thicknesses of over ¾ in. Accompanying the table is an excellent article on welding standardization. Edward Valves, Inc.

PIPING, TRAPS, ACCESSORIES

113 Steel Pipe—Bulletin 370, 32 pp, covering company's CW steel pipe, includes black and galvanized pipe in all standard sizes from ⅛ in. to 4 in., with tables of dimensions, weights, test pressures, threading data, and bundling schedules. Modern fabrication methods and constant development and application of closer controls on mechanized fabricating processes are emphasized. Illustrated in color, booklet presents a picture story of the steps of manufacture from skelp through heating furnaces, the continuous welding process, and finishing operations. Spang-Chalfant Div., The National Supply Co.

114 Design Properties of Pipe—This new 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus what is believed to be the most nearly complete tabulation ever published of the dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

115 Expansion Joints—Bulletin EJ-1012 is a recently revised 12-pp edition of booklet covering both gun-packed and gland-packed expansion joints. Fully illustrated with photos and sectional drawings, cites advantages of both types, discusses construction details, servicing. Includes dimensional data, weights, list prices. Yarnall-Waring Co.

116 Pipe Line Filters—Emphasizing company's Staynew double-action principle, 8-pp Bulletin B-1A describes, illustrates and gives applications and specifications for 75 filters for air and other gases, including pressure and vacuum types. Installations views are shown of the Series 900 filters for air pressure to 6000 psi. Also shown are installations of vacuum and absorption types and special models for removal of carbon black and aluminum oxide. Dollinger Corp.

117 Solving Steam Trap Problems—Now available is the recently revised edition of manufacturer's popular 32-pp catalog on steam traps. Contains up-to-the-minute specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment. Gives pointers on how to install traps with fewest number of fittings in shortest time—and how to service them quickly and efficiently. Illustrated with installation photos of traps, sketches and diagrams of typical arrangements, construction and operation. The V. D. Anderson Co.

118 To Stop those Leaks—Catalog 41-0 offers 28 pp of helpful ordering and application data on pipe repair clamps and saddles, valve and bibb reseaters. Illustrates each product, tells where to use it and how to install it, giving dimensions and prices. Includes an interesting table showing estimated cost of different size leaks in air, steam, water and oil lines. M. B. Skinner Co.

MECHANICAL POWER TRANSMISSION

120 Manual on V-Belt Drives—Catalog 280 is pocketsized, but contains 384 pp of illustrations, tables and other technical information to make it possible to select V-belts for any power transmission drive quickly and accurately. For ease of use, the various sections are printed on different colored paper. List prices, dimensions and an interchangeability list are included, also a 12-pp supplement on cog belt drives. The Dayton Rubber Co.

121 Adjustable Speed Control—Not an ordering catalog, this well-organized 24-pp booklet, Bulletin OEA 5334, presents a concise summary of the economical and engineering benefits to be obtained from properly-applied adjustable speed drives. It provides a check list of points to be considered in selecting a drive and describes and illustrates manufacturer's packaged adjustable speed drives. Includes a comparison chart on performance features and characteristics of drives described. General Electric Co.

122 Flexible Couplings — Illustrated Folder 2363, 4 pp, on company's BC roller chain flexible shaft coupling gives engineering information for proper application. Includes dimensions, weights, service factors, horsepower ratings. Detailed data are also given on two types of protective grease-retaining casings—a spun metal revolving type and a plastic revolving type. Link-Belt Co.

ENGINES, GENERATORS

123 Re-Circulation Steam Generator—Here's a 6-pp folder introducing a controlled re-circulation steam generator, describing its development and recommended uses, such as applications where steam is required in remote locations, where demands are intermittent or load fluctuating. Illustrated by cutaway drawing, text explains generator's operation, principal features. Combustion Engineering-Superheater, Inc.

124 Diesel Engines — Construction and operating features of manufacturer's four-cycle, one-cylinder, and new two-cylinder vertical mechanical injection Type 4PB diesels are presented in Bulletin 123. Those described have 4½ in. bore and 5¼ in. stroke, with electric or manual starting. Within an operating speed range of 1200 to 1800 rpm, the one-cylinder engine develops 10 to 15 hp, the two-cylinder unit 20 to 30 hp. They are offered as self-contained electric generating sets, pumping units, and bulletin shows various engine applications, gives kilowatt ratings, pumping capacities. Pictures main parts, gives specifications. Nordberg Mfg. Co.

HEATERS, HEATING

125 The Case for Space Heaters—Eight-pp Bulletin 526, describing manufacturer's Counterflo direct-fired space heaters in gas or oil fired models with outputs from 400,000 to 2,000,000 Btu per hour, features a comparison chart showing that steel requirements for installation of these heaters are substantially less than those of many other systems. Thirty reasons for their growing acceptance are listed. Heating Dept., Bravo Corp.

126 Why Open-Coil Heaters—The direct economies of heating boiler feedwater and the advantages of open-coil construction in company's feedwater heaters and purifiers are discussed in detail in illustrated Bulletin 117, 16 pp. Covers deaerating and non-deaerating type heaters. Stickle Steam Specialties Co.

127 Heat Transfer Equipment—Catalog 19, 4 pp, is essentially an illustrated index of manufacturer's equipment, including

(Continued on page 114)

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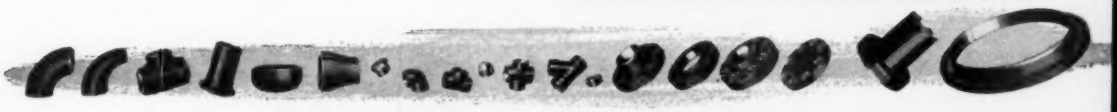
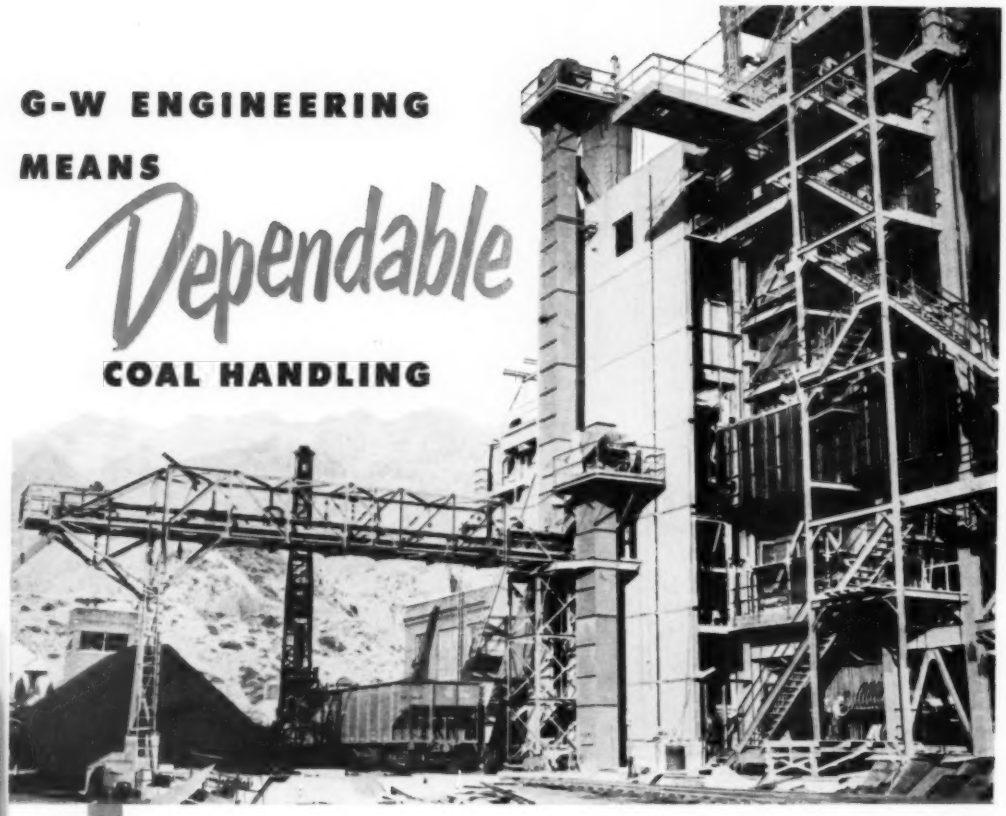


G-W ENGINEERING MEANS *Dependable* COAL HANDLING



The Gifford-Wood coal handling system at the Orem steam electric station of Utah Power & Light Company is designed to handle run-of-mine bituminous coal at 100 tons per hour from dual track hoppers to ground storage, or to overhead storage bins for automatic delivery to boilers. Coal handling is automatic... economical... completely dependable. The installation, protected by electrical interlocks, is a perfect example of the rugged design and flexibility that can be built into the operation of a well designed power plant.

This complete coal preparation and handling system is but one of the many solutions to dependable low cost coal handling... Solutions designed by G-W engineers... based upon over 135 years of experience accumulated by G-W in the methods of design, engineering and installation of all types of materials handling systems. Bulletin No. 300 contains the complete story. Send for your copy now, it may well lead to lowered costs tomorrow.

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get 30% Fuel savings ... with new B&W Boiler

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Do you have similar problems in steam for power, processing, or heating? Write to America's 80-year-old firm of boiler specialists . . . for new Bulletin G-71. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

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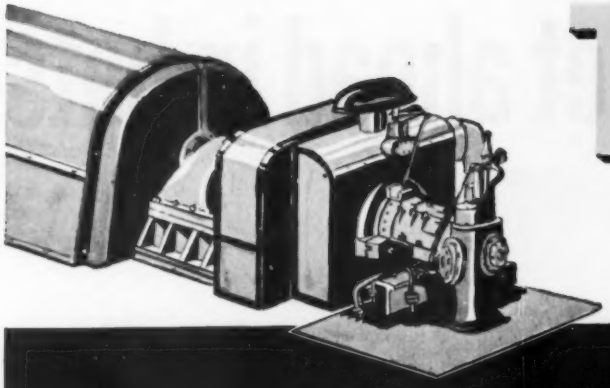
G-503



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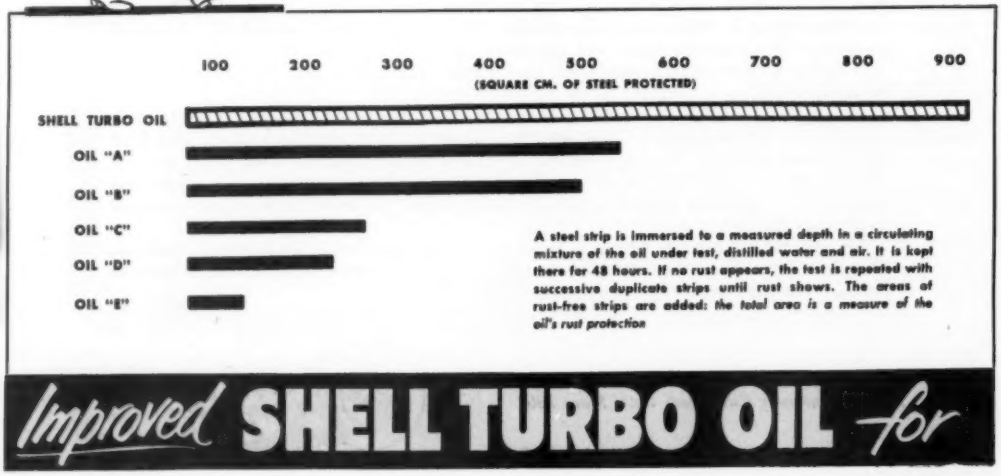
"LOOK AT THESE RUST-PROTECTION FIGURES"



A steel strip is immersed to a measured depth in a circulating mixture of the oil under test, distilled water and air. It is kept there for 48 hours. If no rust appears, the test is repeated with successive duplicate strips until rust shows. The areas of rust-free strips are added: *the total area is a measure of the oil's rust protection*

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Because of the tremendous responsibility entrusted to operators of large steam turbines, and because of the heavy investment each unit represents, Shell Oil Company has been concentrating on a lubricant research project of primary importance to utility and industrial executives.

The product now offered, Improved SHELL TURBO OIL, exceeds *every* accepted specification for premium turbine lubricants. It offers these five outstanding improvements:

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Samples and complete information on the Improved Shell Turbo Oil will be sent promptly on receipt of your letterhead request. Address: Shell Oil Company, 50 West 50th Street, New York 20, N.Y. or 100 Bush Street, San Francisco 6, California.

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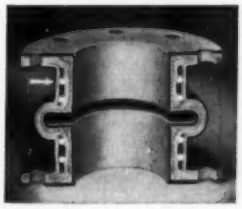
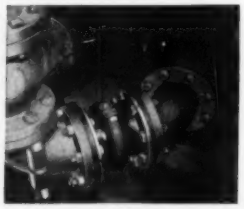
1. Made of high-grade rubber, they do not crack or fracture under repeated flexing.
2. They do not take a permanent set.
3. For pressures from 40 to 125 p.s.i.; and for vacuum of 30 in. of mercury.
4. Suitable for operating temperatures up to 180°F.
5. They do not corrode or erode.
6. They are light in weight and can be installed in a limited space.
7. They require no gaskets between the flanges of the joint and the flanges of the pipe.
8. They do not induce electrolysis.

Garlock "multiple arch" Rubber Expansion Joint.



Arrow points to one of steel reinforcing rings in single arch joint.



Garlock expansion joints are furnished in all pipe sizes from 2" to 72".

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ASSURED SUPPLY OF HIGHEST QUALITY BOILER FEED WATER—WITHOUT EVAPORATION

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An adequate supply of highest quality, conditioned water is assured with AMBERLITE Ion Exchange Resins. Even when dissolved solids in the raw water are at a high level and peak output is required, ion concentration of the treated water can be maintained at 0.1 p.p.m. or less. Silica, carbon dioxide and hardness are almost completely eliminated, often in *one* pass through *one* exchange column.

For details about low-cost, *silica-removing deionization*, send for our bulletin on AMBERLITE Ion Exchange Resins. Then discuss the AMBERLITE process with your consulting engineer or water conditioning equipment supplier. He'll be glad to help you choose the multiple-bed installation or Monobed unit that suits your specific needs.

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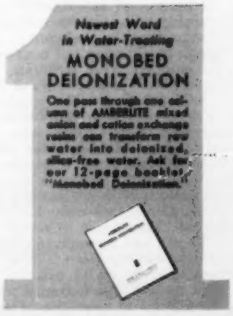
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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—UNIVERSAL STEAM TRAP

Incorporates seven different devices in one compact unit

This unit, weighing 8½ lb, is said to offer the same capacity and efficiency of many 2 in. traps weighing up to 200 lb. Combined in it are a steam trap, air bypass valve, check valve, self-cleaning strainer, flow control glass, temperature indicator gage and temperature control. Standardization on one type is described as a further advantage, as one type in one size replaces a range of steam traps from ½ to 2 in. in size.

This trap can be installed in any position and in its vertical position is frostproof, company reports. It is opened by steam pressure and closed by thermal action, a new method of steam trap operation.

The bimetal element operating the trap is a function of the saturated steam curve so one trap can be used for a wide range of steam pressures and temperatures. In superheated power plants it can handle pressure of 650 psi and temperatures to 1000 F, according to manufacturer. Velan Engineering Co.

2—ROTARY SELECTOR SWITCHES

Now made with up to 6 poles, 15 positions per pole, on each deck

The large number of poles and positions on each deck of these switches is made possible by use of company's "knee-action" type of rotor arm. This is said to insure low contact resistance and uniform contact pressure over the life of the switches. Silver alloy contacts and rotor arms are used on all units. It is pointed out that because of the increased number of pole decks available, more compactness can be obtained. A new roller-type detent is also standard on the units to give more positive action and longer service life. Daven Co.

4—OIL RECLAIMERS

For reclaiming diesel and gas engine compressor lubricating oils

This new line of Hilco Oil Reclaimers incorporates rotary type pumps, high capacity regenerative heat exchanger, vacuum pump lubricating system and general rearrangement for ease of servicing and longer equipment life.

The process involved consists of first filtering the oil through a bed of Hilite fuller's earth for straight-run mineral oils or Adstay Filter Discs for heavy-duty detergent type oils. After filtering the oil flows into a vaporizer where water, moisture and fuel dilution are removed and then the oil passes through the high capacity regenerative heat exchanger where heat is transferred to the cold incoming oil. Vapors resulting from the condensation of water and fuel dilution pass to a distillate receiving tank. These units are continuous and automatic in operation and come in capacities from 2 to 500 gal per hr. The Hilliard Corp.

5—IMPROVED TRANSFORMERS

Are simpler, smaller units, easier to ship and service

Design improvements incorporated in company's CPS Transformers include fewer doors and padlocks; two padlocks now lock four doors on front. Potential transformers are now of the draw-out type to facilitate fuse changing. The arrester bracket is welded to the tank on the high voltage side to lower the profile, a feature intended to improve appearance and make the arrester more stable.

The removable frame formerly required for shipping has been eliminated by building the braces inside, and all standard ratings now feature manufacturer's Sealdaire construction which not only eliminates auxiliary compartment but makes more tank wall available for cooling and reduces floor plan dimensions. Internal network potential transformers have also been eliminated on standard designs. These are seldom required, company states, but if necessary, can be put on the roof of the transformer. Ventilators have been eliminated from wall panels, stretcher level steel used in door and wall panels. Westinghouse Electric Corp.

6—SAFETY SIGNS

Are printed on strong cotton cloth with a self-adhesive backing

Quik-Label Safety Signs carry their message in large bold letters on the proper safety background color. They have a silicone plastic coating to protect against dirt, grime, moisture and weather, and may be used indoors or outdoors. Mounted on handy dispenser cards, the signs may be easily removed from the card and instantly applied. They stick without moistening to any clean surface. W. H. Brady Co.

3—POCKET-SIZE pH METER

And companion probe unit for on-the-spot pH determinations

Everything you need for making pH determinations is included in this compact, easily operated instrument. Self-contained with batteries, it is furnished with plastic tubes of buffer and KC1 solutions. The whole set-up weighs only 3 lb and comes in a waterproof carrying case with combination hand-and-shoulder strap.

Calomel and glass electrodes are combined with sample holder in a single polythylene probe unit, and a sample volume of only 0.5 ml is required. The meter is scaled from 2 to 12 pH, but a simple adjustment provides readings from 0 to 15. Accuracy is given as 0.1 pH.

Hearing-aid type batteries provide up to 1300 hr of operation, company states, and the electrometer tube, switch and input connector are sealed in a single unit to insure freedom from high humidity. Grounded samples can be directly measured because of no external power connections. Analytical Measurements, Inc.

7—CHECK VALVES

Are ultra-sensitive, for extra low pressure applications

The 119-Series Valve incorporates company's Circle-Seal principle and is similar in design to their standard check valves, but is intended for very low pressure pneumatic or gas systems where the slightest whiff of pressure must open the valve and absolute sealing is necessary. It was originally developed for use in air thermostat control systems, where the check valve is required to isolate units of the system.

This new low pressure valve is normally made in brass or aluminum, but other materials are available. Cracking pressure is 4 to 8 in. water column. The valve seals before the pressure across the poppet is equalized and holds bubble tight against any back pressure

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within its rated range of 0 to 100 psi, manufacturer states. Sealing is by a poppet with a machined knife edge impressed into the surface of an O-ring. Accurate centering of the knife edge on the O ring with valve mounted in any position is credited to a special design feature. James-Pond-Clark.

8—RECLOSING RELAY

For use on automatic reclosing equipment with power circuit breakers

Features of the new type ACR Relay, not available in company's previous design, are: optional automatic reset at a definite time after any successful reclosure attempt; a self-contained means for permitting instantaneous initial and time-delay subsequent breaker tripping, and faster immediate reclosure. Completely automatic reclosing equipments protect feeders against unnecessary outages due to temporary faults, by automatically restoring service.

The ACR may be adjusted for one, two, or three delayed reclosures in addition to immediate reclosure. Delayed reclosures occur at 15 sec minimum intervals. By adjustment of cams, longer intervals can be obtained; or definite-time reset after immediate reclosure attempts omitted. Connections can be changed to omit immediate initial reclosure. Switchgear Divs., General Electric Co.

9—PIPE COATING

To protect against corrosion from soil acids or air-suspended acids

Pro-Tek-To is a Gilsonite-asphalt base, asbestos fibre coating formulated for use on pipelines and metal structures. It is economical to use because it requires neither heating nor special mixing and is easily applied by paint brush or pipe coating machinery. It can be used with or without conventional wrappings and manufacturer says it is equally effective indoors or outdoors, is impervious to severe temperature changes and retains its mastic properties through its long service life. It can be used on underground as well as aboveground installations. The Warren Refining & Chemical Co.

10—CONDUCTIVITY CELL

For ultra pure water, is newly developed high pressure type

This high pressure cell is designed for measurement of specific resistance of water as high as 18 megohm at 25 C from mixed bed deionizers. Constructed of nickel and teflon and rated up to 500 psi, the cell is provided with a 2-in. npt fitting for pipe line or tank installations. Industrial Instruments, Inc.

11—STEAM JACKETED PUMP

Is herringbone gear type for handling hot, viscous liquids

To insure even thermal distribution, the steam jacket on these pumps completely covers the internal parts. The inlet, outlet and cover flanges are cast integral with pump base, and housing is rigidly constructed to eliminate possibility of distortion due to pipe line strain or misalignment. Straight bore housing also prevents shaft deflection and bearing overhang, company points out. Shafts are heavy duty alloy steel, finish ground.

Pressure on stuffing box is dissipated through a channel in the cover plates. Steam connections on pump jackets are accessible and designed for a variety of piping arrangements. Complete rotor and bearing assembly can be removed as a unit by releasing the coupling and removing the rear cover.

Gears are case-hardened, press-fitted and keyed to shaft. To prevent slippage, the gear teeth have a specially designed high pressure angle tooth. Pumps are available in Meehanite B, cast steel, bronze or special alloy case. Internal parts built to specifications. Schutte and Koerting Co.

12—ENTRANCE SEAL

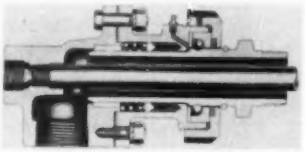
For high voltage cables, utilizes bushings of a rubber material

The Type RS Cable Entrance Seal uses bushings of Resistoyl compressed in a stuffing box to form a pressure-tight, oil- and moisture-proof seal on all types of leaded and non-leaded cables. Bushings of the Resistoyl material are held between metal discs and compressed by tightening a gland nut. Since these bushings are a part of the cable entrance, the proper mass of material to form an effective seal is said to be always present when the entrance is installed. Fittings for use with conduit and wire or tape armor are available for use with the RS cable entrance. G & W Electric Specialty Co.

13—REVOLVING JOINT

For piping connections to drum type dryers, other rotating equipment

The compact Type IBR Joint is characterized by low torque, thus offering power savings. Models are available for handling steam, oil, ar, water, gas and chemicals. The rotating portion of the joint consists of a steel tube which screws into the hub of an oil drum. The non-rotating portion is ball bearing mounted on this tube. Ball bearings



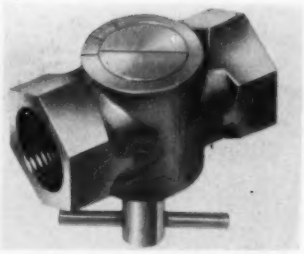
carry the load of both radial and end thrust. Self-adjusting and self-sealing chevron type packing under light spring pressure is used to provide a long life seal on the rotating tube. Type IBR joints can be serviced usually without removing the joint from the roll.

Built for 150 psi, steam, or 200 psi, hydraulic, and also for vacuum service, these joints are recommended for speeds to 500 rpm steam, or 750 rpm hydraulic, and for temperatures to 450 F, depending on packing specified. Standard sizes range from ½ to 2 in. Barco Mfg. Co.

14—FLOW REGULATING VALVE

For use where exact setting of regulated flow of liquid is required

Described as a de luxe stop cock, this flow regulating valve is suggested for jet pumps and spray pumps, as a by-pass valve on boiler feed lines, and wherever a quick-opening, easy-operating flow regulating valve or stop cock is needed. Valve won't leak externally, company states, and close fitting permits only the slightest internal weeping. In



spite of the close fit, the plug turns easily for accurate manual adjustment.

Valve features all-brass construction, O-ring packing and quarter-turn opening and closing. It is 2½ in. long, for ¾ in. pipe size. Two plug types are available, one full ported with arc of 1 in. pipe in port, and the other with ¼ in. port for fine adjustments. Reynolds-Shaffer Co.

15—CAPACITOR

Features smaller size and permits higher operating temperature

Newest of company's small capacitors is the micro-miniature Type 123Z, which is tubular rated at 85 C and declared capable of operating at 100 C, thanks to its vitrified ceramic sealed metal can. Yet it measures only 0.175 in. in dia by $\frac{7}{8}$ in. long. It is rated at 200 v d-c, 0.01 mfd. Aerovox Corp.

16—STOKER EQUIPMENT

For efficient burning of sawdust, wood chips and other wood refuse

Wood working industries with a surplus of waste can frequently supply smaller boiler plants in the vicinity with low cost fuel. It is pointed out that wood waste can be burned efficiently in the average furnace if a few necessary modifications are made and adequate stoker equipment provided. The Fyr-Feeder Automatic Multi-Burner Combustion System is suggested for this purpose. Fyr-Feeder Engineers Div., American Coal Burner Co.

17—5-W POWER RESISTORS

Are now available in higher resistance values, up to 10,000 ohm

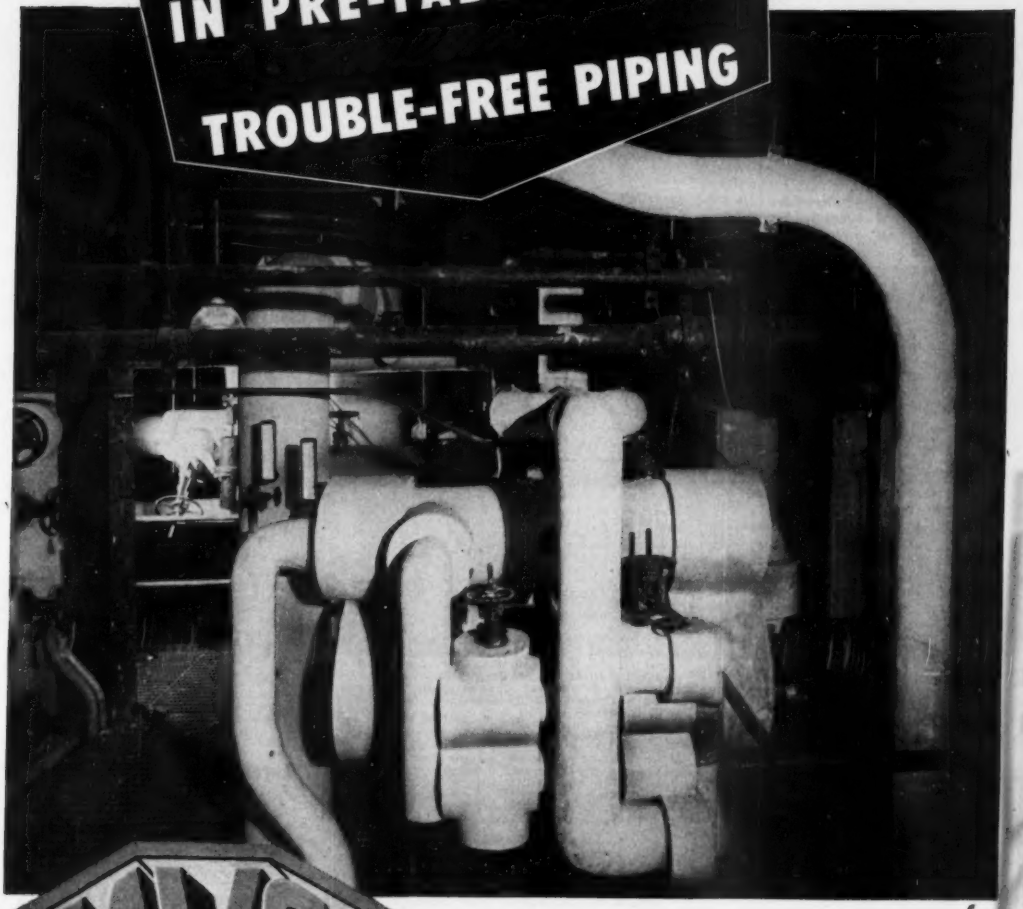
PR Greenohms—5-w fixed wire wound resistors with inorganic-cement coating—may now be had in 8000, 8500, 9000 and 10,000 ohm resistance values. In the Series AC 10 F or 10 w Greenohms a 9000 ohm value has been added between the 8500 and 10,000 numbers. Clarostat Mfg. Co., Inc.

18—FUSE TUBES

Offer complete interchangeability in given voltage ratings

Manufacturer of this expulsion power fuse line announces that by simply

NAVCO ACCURACY IN PRE-FABRICATION TROUBLE-FREE PIPING



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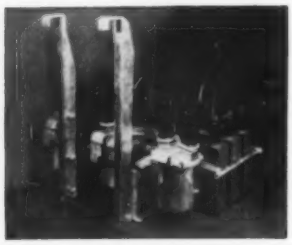
changing or replacing the fuse tube assembly, eight combinations of continuous current and interrupting capacities are possible in each kv rating. In one operation this fuse can be converted to meet any one of a variety of load conditions. Another feature of the new fuse line is a completely housed snubber to bring the opening tube assembly to a cushioned, shock-free stop. Classified LB, MB and HB, the new fuses are available in six ratings from 7.5 to 69 kv. Southern States Equipment Corp.

19—POLE-TOP CAPACITORS

Are factory assembled, wired, ready to hoist into place on the crossarm

Equipment in these small packaged capacitor banks consists of nine 25-kva capacitor units and three of company's solenoid-operated Type CSO-1 switches. Only three line and three control wire connections are needed to put it in service. Recent developments of the



200-amp, 15-kv load interrupter switch, the CSO-1, is credited with making possible wider use of automatically-switched capacitor banks and helping meet the need for quick additional kva capacity. This switch will operate about 5000 times before needing maintenance, company says.

The unit is available with either nine or 12 capacitors, rated 15- or 25-kva, 2400 to 7960 v. Time clock and voltage or current controls can be supplied. Westinghouse Electric Corp.

20—FLOW INTERLOCK

Responds to a flow of water to open or close an electrical contact

According to company engineers, this new design includes a finer differential, union fittings at both ends, a bronze piston, reduced size and weight, simpler adjustment and more wiring space. In operation, it closes a contact when a flow of water exceeds a preset amount and opens it when the flow falls below the preset amount—acting like a fuse in a circuit which depends on water cooling for protection.

The interlock can be used as a safety device in hot water heaters, welding units, transformer cooling, induction heating, water-cooled dynamometers. A screw sets the circuit for any flow from ½ to 4 gpm. The flow differential between the cut-in and cut-out of the electrical contact is 0.1 gal maximum. The interlock does not control the amount of water flow, but this can be accomplished by installing a throttling or regulating valve ahead of the service.

A strainer attachment keeps foreign matter out of the housing, and the double union fittings simplify installation into a line. The housing is protected from water damage by a triple-seal cork and chamois insulation. Designed to operate for the amount of flow independent of pressure, this interlock is intended only for cold-water applications. Its electrical rating is 10 amp at 120 or 240 v a-c. Maximum line pressure it will withstand is 125 psi. Control Divs., General Electric Co.

21—THREE-PHASE TRANSFORMERS

Now feature lighter weight and more compact construction

Company's SpiraKore construction, utilizing cold-rolled, oriented-grain steel, has been extended to three-phase transformers rated 150 kva and less, 15 kv and below. The new construction, available on single-phase transformers since 1937, makes it possible to produce units of lower weight, smaller dimensions and lower exciting current. In some ratings the weight savings are as much as 30 per cent.

In the conventional three-phase butt-lap core, the flux flows at cross angles to the grain in a large portion of the magnetic circuit and the air gaps are small in area. In the SpiraKore design the flux is parallel with grain of core steel throughout most of the magnetic circuit. The effective number of gaps is reduced and the gap area is large, resulting in lower exciting current. The reduced weights and dimensions of three-phase SpiraKore transformer are also said to result in easier handling and less costly pole line construction. Transformer and Allied Products Divs., General Electric Co.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

INSTRUMENTS AND CONTROLS

201 **For Centralized Control** — Bulletin 109, 4 pp, presents the new, compact Mini-Line equipment suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve and remote manual relay. Bailey Meter Co.

202 **Remote Reading Flow Meters**—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

203 **Flow Meters**—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, bulletin discusses meter's advantages. Builders-Providence, Inc.

204 **Putting the Ratio Totalizer to Work**—Twelve suggested applications of company's ratio totalizer in automatic control circuits are described and illustrated by diagram in 8-pp Bulletin 5450. This new device is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Hagan Corp.

205 **For Practical Men**—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. James G. Biddle Co.

206 **Air Locks**—Bulletin S-31, 2 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. The Swartwout Co.

207 **Flow Tubes** — Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function and discusses their advantages. Foster Engineering Co.

208 **Control equipment** — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pilot equipment. Simplex Valve and Meter Co.

HEATERS, HEATING

209 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. Davis Engineering Corp.

210 **Fan Heater Bulletin** — Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. Niagara Blower Co.

211 **Tubular Heat Exchangers** — Bulletin 916, 32 pp, describes tubular heaters, coolers, condensers and heat exchangers and their features. The various types of shells, tube bundles, stationary heads and floating heads are explained. Includes tables showing characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presents charts of specific heats of midcontinent crudes and for solving MDT formula with correction factors. The Griscom-Russell Co.

BOILERS AND AUXILIARIES

212 **Shop-Assembled Boiler** — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming. The Babcock and Wilcox Co.

213 **Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discusses its advantages. The Wickes Boiler Co.

214 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators other equipment. Thomas C. Wilson, Inc.

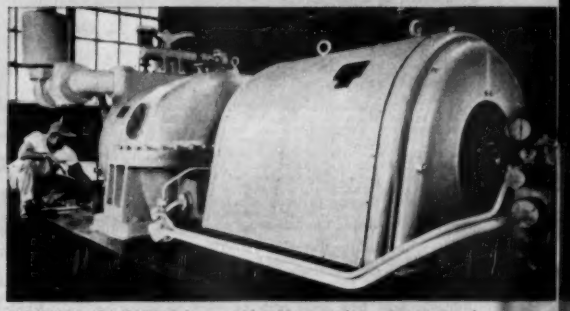
215 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors, hose. Roto Div., Elliott Co.

216 **Water Tube Boilers**—Eight-pp Bulletin SB24B describes and illustrates water cooled boilers with integral water cooled furnace. Explains design features that contribute to positive circulation and low maintenance, as well as construction advantages. Includes dimensions, photos of five installations. Erie City Iron Works.

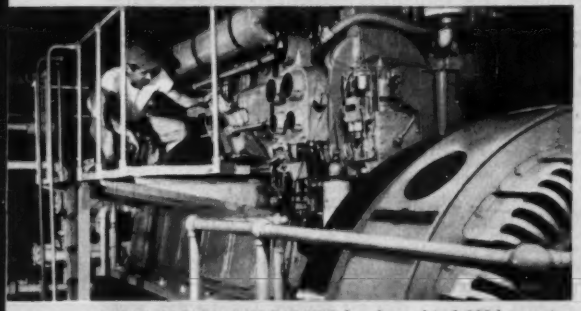
NANTUCKET ISLAND can't tie in with mainland power facilities and must therefore be entirely self-sufficient. To assure unfailing performance, the Nantucket Gas & Electric Company uses Sun lubricants exclusively. Also, engineers of the utility, of the diesel builders, and of Sun Oil cooperated to make possible a unique, three-way use of one inexpensive Sun fuel.

HOW SUN PROTECTS NANTUCKET'S POWER

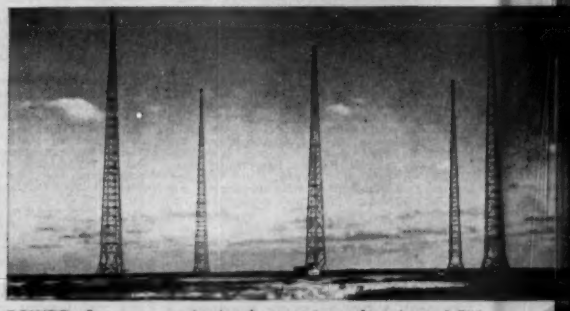
THE ISLAND'S POPULATION drops from around 16,000 to some 3,800 when the vacation season ends. With the power load fallen off so drastically, much of NG&E's equipment lies idle and subject to condensation during this extended time.



DESPITE IDLENESS for considerable periods, turbine journals, bearings and controls remain free at all times of sludge, rusting and corrosion—thanks to the protection of Sunvis 916. Its special metal-wetting additives displace any moisture that may be present.



A SUN DIESEL LUBRICANT has kept this 1,000-hp engine purring almost 15,000 hours. A single heavy, low-cost Sun fuel drives NG&E's diesel, fires its boilers, enriches its illuminating gas.



POWER for a new navigational transmitter, throwing a 1,700-mile beam for guiding aircraft, is supplied by Nantucket G&E—more evidence of the reliance placed on its Sun-lubricated plant.

For complete information about Sun's turbine and diesel oils, or for the services of a Sun representative, call the nearest Sun Office, or write to Dept. PP5

SUN INDUSTRIAL PRODUCTS

SUN OIL COMPANY, PHILADELPHIA 3, PA. • SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

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217 Air Preheaters—Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. Several installations are illustrated. The Air Preheater Corp.

218 Soot Blower Head—Illustrated Bulletin 485, 4 pp, describes a new rotary soot blower head for improved boiler cleaning. Explains how blower head is designed to give maximum blowing pressure through the full blowing arc, is rugged, easily serviced, economical. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

WATER TREATING, CORROSION PREVENTION

219 Water Conditioning Information—Here are three informational bulletins of value to power engineers. No. 28X7446 describes a simple and accurate way to determine total hardness in water, illustrating procedure and explaining principle. No. 28X7559 gives an analysis of the hot process-hot zeolite system, telling results to be expected and advantages. No. 28X7466 discusses current status of embrittlement in boilers, explaining causes and telling recent developments in control methods. All three bulletins available, list those wanted. Allis-Chalmers Mfg. Co.

220 Modern pH and Chlorine Control—This 100-pp booklet gives technical details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

221 Water Softeners — Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. Graver Water Conditioning Co.

222 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment are pictured and described. Bulletin tells how tests may be used to determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

223 Boiler Water Treatment — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used. National Aluminate Corp.

224 Ion Exchange Systems — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids. The Resinous Products Div., Rohm & Haas Co.

225 Pocket Book on Chemicals — Here's a handy little 28-pp manual covering chemical products used by the power engineer. Most of those listed are water treating chemicals, but there's also a brine treatment, a fuel oil sludge dispersant, a soot remover, and protective coating. Tells what each product does and how and where to use it. Includes a helpful reference chart suggesting the application of these products. Western Chemical Co.

226 Boiler Water Manual—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system, condensate returns, flushing. %Proportioneers, Inc.%

227 Water Softening Equipment — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Illustrates a fully automatic softener. The Permutit Co.

228 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations to suit individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment and test control. Filled with illustrations, this helpful booklet also describes available equipment and includes a reference bibliography of literature on specific formulations. Dearborn Chemical Co.

229 Boiler Corrosion—A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. W. H. & L. D. Betz.

230 Two-Stage Water Conditioner—Bulletin 4801 describes a water conditioner which combines advantages of both hot process and zeolite softening. Explains operation of softener in which first stage is the hot process using lime or Dolomitic lime and second stage the zeolite reduction of hardness. Cochrane Corp.

231 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Gives case histories and economies obtained by power plants using this treatment. The Bird-Archer Co.

232 Slurry Type Softener—Six-pp Bulletin W-212-B6 describes a slurry type precipitating softener and coagulator in which energy for floc preparation is mechanical, explaining and illustrating flow circuit. An excellent question-and-answer appraisal of system is included, and equipment is pictured. Worthington Pump and Machinery Corp.

ELECTRICAL

233 The Why of Dry Type Transformers —Booklet B-4428, 24 pp, discusses reasons why dry-type transformers are safer and less expensive to install and maintain in industrial plants and utilities. Types of air-cooled transformers for every use are illustrated from small ones for operation of intercommunication systems to power centers as large as 10,000 kva. Also describes sealed, submersible, dry-type transformers for installation underground. Westinghouse Electric Corp.

234 Power Factor Correction—Examples showing basic considerations in the improvement of system power factor are contained in Bulletin 05B7465, 4 pp. Points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher; tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

235 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features. Elliott Co.

236 Care of A-C Rotating Equipment—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and such subjects as drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

237 Buyers' Manual on Motors and Control—Fifty-pp Catalog GEC-1009 persents buying information on a carefully selected group of motors, motor starters, control accessories and electronic control. Ratings listed are those most frequently required. Excellent data on proper selection of this equipment is provided as well as full descriptions, dimensions, ratings, prices. Fully illustrated. General Electric Co.

VALVES, TRAPS, PIPING

238 Bonnet Valves—"Pressure-Seal" bonnet valves are described and illustrated in Form AD-1819. Includes sizes, dimensions, ratings and tests for gate, globe, angle and stop check valves for high pressure and high temperature service. Also explains operating advantages, tells how pressure seal is made. Crane Co.

239 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blower, water column blow-down, and other types of pipe line. Includes tables of dimensions, weights; list prices. Everlasting Valve Co.

240 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

241 Blow-Off Valves—Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles are illustrated by cutaway drawings. Dimensions and specifications included. Yarnall-Waring Co.

242 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes—150 to 2500 lb—and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains special design features, gives construction details, dimensions, ratings, material specifications. Edward Valves, Inc.

243 Valves, Fittings and Flanges—Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides not only ordering information on company's complete line, but also much helpful engineering and application data, and includes a section on products for refrigeration service. Fully illustrated, well-indexed. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

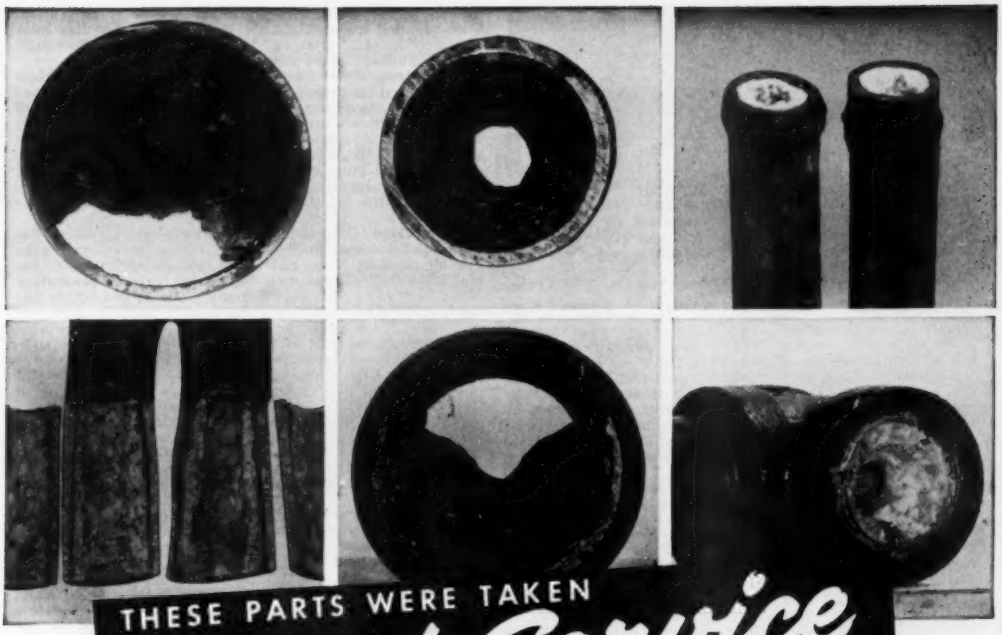
244 Automatic Valve Specialties — Company's pressure, flow, and liquid level controls for steam, air, gas, water, oil and other fluids are shown in 60-pp Condensed Catalog A-50. All equipment is described as to construction and application. Dimensions and prices are included. Technical data includes capacity charts and conversion tables. Davis Regulator Co.

245 Pressure Reducing Valves—Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Also described is company's desuperheater. Northern Equipment Co.

246 Steam Traps and Temperature Controls—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Contains sizes, application data, prices. Sarco Co., Inc.

247 Steam, Air, Gasoline Traps — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables, installation diagrams. W. H. Nicholson & Co.

(Continued on page 118)



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BECAUSE OF SCALE

DEARBORN FORMULA 134 REMOVES SCALE

● These destroyed parts represent a large, unnecessary investment in equipment, labor and shut-down time. Conditions like these can easily and economically be avoided with Dearborn Formula 134. Wherever water travels—scale tends to form. Formula 134 is a concentrated solvent for the rapid removal of scale in heat exchange units, boilers, pumps, feed lines, meters, condensers and other valuable equipment.

Formula 134 is just one of many Dearborn formulas used to save equipment, reduce shut-down time and maintenance costs. Other Dearborn formulas control acidity of condensate, prevent excessive foaming and prevent corrosion of metal in contact with calcium and sodium chloride refrigerating brines. For the correct water treatment to best meet your needs—consult Dearborn.

SAFE, SIMPLE APPLICATION

with specially designed, inexpensive pump also supplied by Dearborn! Send for Bulletin 5002 which describes in detail methods for the removal of scale with Dearborn Formula 134.

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Please send me information on Dearborn Formula 134.

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TRADE MARK REGISTERED

THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

POWER PLANT Construction News

Pride, Ala.—Tennessee Valley Authority, New Sprankle Bldg., Knoxville, Tenn., is projecting plans for new steam-electric generating station on site selected at Pride, near Tuscumbia. Entire project estimated to cost $47,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment.

Los Angeles, Calif.—General Refractories Co., 3201 Fruitland Ave., Vernon, Los Angeles, plans boiler house at proposed new plant on Randolph Ave., Maywood District, for production of refractory bricks and shapes. Entire project reported to cost about $1,000,000. Main offices of company are at 1520 Locust St., Philadelphia, Pa.

Bunnell, Fla.—Lehigh Portland Cement Co., 718 Hamilton Ave., Allentown, Pa., plans boiler house at proposed new mill at Flagler Beach, near Bunnell, where large tract of land has been acquired. Project will comprise several large processing and production units and will represent a total investment reported at $11,000,000. Work is scheduled to begin soon.

Boise, Ida.—Idaho Power Co., 1220 Idaho St., is arranging fund of about $22,800,000 for expansion and improvements in plants and system during 1951, of which approximately $16,300,000 will be used for construction of new hydroelectric generating plant on Snake River, near Mountain Home, Ida., now in course of construction. Plant will be known as C. J. Strike station.

Indianapolis, Ind.—Public Service Co. of Indiana, Inc., 110 N. Illinois St., has arranged financing in amount of $40,000,000, to be used in expansion and improvements in plants and system over a 36-month period, from 1951 to 1953, inclusive, including expansion in generating facilities, power substations, transmission lines and distributing system.

Tyrone, Ky.—Kentucky Utilities Co., 159 N. Main St., Lexington, Ky., has completed plans for proposed addition to steam-electric generating plant at Tyrone, to be known as Unit No. 3. Contract has been let for steel frame superstructure and work is scheduled to begin soon. Sargent & Lundy, 140 S. Dearborn St., Chicago, Ill., are consulting engineers.

Vienna, Md.—Eastern Shore Public Service Co., Salisbury, Md., has authorized expansion in steam-electric generating station at Vienna, with installation of 20,000-kw turbine-generator unit, high-pressure boiler and auxiliary equipment. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is consulting engineer, and will supervise project.

Marine City, Mich.—Detroit Edison Co., 2000 Second Ave., Detroit, Mich., has authorized further expansion in new steam-electric generating plant, now in course of construction, on St. Clair River, vicinity of Marine City, with installation of a third 125,000-kw turbine-generator unit and auxiliary equipment. Plant will have a total rating of 375,000-kw, and is scheduled for completion before close of 1953.

Newark, N. J.—Mennen Co., 345 Central Ave., Newark, shaving cream, powder and other toilet preparations, plans boiler plant at proposed new factory in Collinsville district, Morris County, where tract of 50 acres of land has been acquired. Factory will comprise several units and is reported to cost $2,500,000.

New York, N. Y.—Consolidated Edison Co., 4 Irving Pl., has arranged appropriation of about $104,000,000 for expansion and improvements in plants and system during 1951. Of amount noted, approximately $75,000,000 will be used for expansion in electric-generating and distribution facilities, including expansion in East River plant on 14th St., and Hudson-Gold generating station, Brooklyn, with installation of generating and auxiliary facilities for increased capacity.

McConnellsville, Ohio—Ohio Power Co., 305 Cleveland Ave., S.W., Canton, Ohio, has plans maturing for proposed new steam-electric generating plant on Muskingum River, near McConnellsville, where large tract of land recently was secured. It will be equipped for an ultimate capacity of 400,000-kw, and is reported to cost close to $45,000,000, with power substations, transmission lines and other operating facilities.

Marion, Ohio—State Dept. of Public Welfare, State Office Bldg., Columbus, Ohio, has plans maturing for new steam-electric power plant for service at institution at Marion. Cost reported about $3,250,000 and appropriation has been arranged in that amount. Miller & Voinovich, Swetland Bldg., Cleveland, Ohio, are architects.

Miamisburg, Ohio—Dayton Power & Light Co., 25 N. Main St., Dayton, Ohio, plans expansion in steam-electric generating station, in vicinity of Miamisburg, with installation of two new 60,000-kw turbine-generators, high-pressure boilers and auxiliary equipment. Entire project reported to cost in excess of $25,000,000, including power substations, transmission lines and other operating facilities. Company also will make improvements in local power plant on E. Third St., with installation of new boiler units and accessory equipment.

Niles, Ohio—Ohio Edison Co., Youngstown, Ohio, has authorized increase in capacity in new steam-electric generating plant at Niles, now in course of construction. Installation will include two 106,000-kw turbine-generators, instead of one such unit as initially planned, and which latter is scheduled to be ready for service early in spring of 1953, with increase authorized, entire project will represent a reported investment of $32,000,000, including power substations, transmission lines and other facilities.

Oklahoma City, Okla.—Oklahoma Gas & Electric Co., 321 N. Harvey St., has arranged an appropriation of about $20,200,000 for expansion and improvements in plants and system in 1951, including generating stations, power substations, transmission lines and other operating facilities. Of this amount, approximately $8,500,000 will be used for new steam-electric power plant, near Sulphur, Okla., recently referred to in these columns, to be equipped for initial capacity of 66,000-kw.

Tulsa, Okla.—Public Service Co. of Oklahoma, 600 S. Main St., Tulsa, plans expansion in Southwestern steam-electric generating station, with installation of new 80,000-kw turbine-generator and auxiliary equipment. Proposed to begin work soon.

Holtwood, Pa.—Pennsylvania Water & Power Co., Holtwood, plans expansion in local steam-electric generating station, with installation of additional equipment for increased capacity. Contract has been let for steel frame superstructure and work is scheduled to begin soon. No estimate of cost announced.

Morrisville, Pa.—General Refractories Co., 1520 Locust St., Philadelphia, Pa., plans boiler plant at proposed new works at Morrisville, for production of silica refractory brick and shapes for steel mill service. Tract of about 58 acres of land had been acquired. Entire project will consist of several units and is reported to cost about $3,000,000.

Phoenixville, Pa.—Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, Pa., will begin work soon on proposed new steam-electric generating station, near Pheonixville, to be known as Cromby power plant. Station building will be 100 x 120 ft, with height equivalent to a six-story structure. Plant will have a rating of 150,000-kw; high-pressure boilers will be equipped to utilize either coal or oil as fuel. Entire project will represent a reported investment in excess of $25,000,000, and is scheduled for completion early in fall of 1953.

Westerly, R. I.—Narragansett Electric Co., 51 Westminster St., Providence, R. I., has approved plans for new Diesel-electric generating plant at Westerly, with installation to comprise five 1000-kw engine generator units and auxiliary equipment. Work will begin soon and is scheduled for completion by close of 1951.

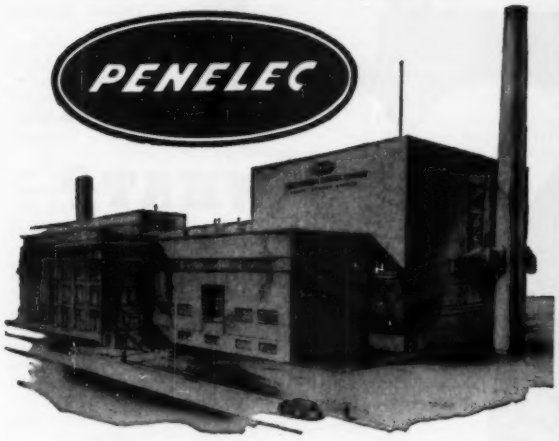
Bishopville, S. C.—Reeves Bros., Inc., 54 Worth St., New York, N. Y., cotton goods and other textile products, plans boiler house at new textile finishing mill at Bishopville, where tract of about 70 acres of land has been acquired. Entire project will cost about $2,000,000. Lockwood, Greene Engineers, Inc., Montgomery Bldg., Spartanburg, S. C., is architect and engineer.

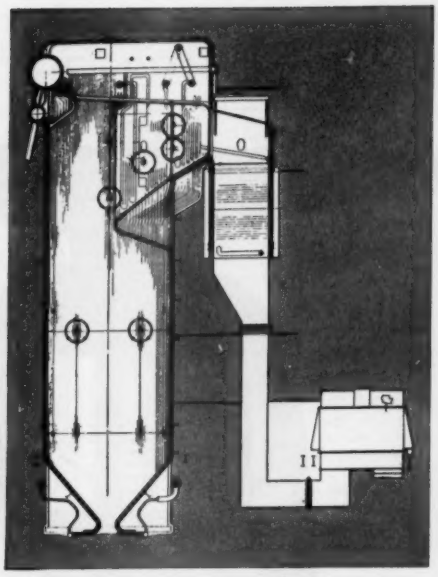
Amherst, Tex.—Southwestern Public Service Co., Amarillo, Tex., has approved plans for new steam-electric generating station, near Amherst. No official estimate of cost announced. Work scheduled to begin soon.

Port Arthur, Tex.—Koppers Co., Inc., Chemical Division, Coppers Bldg., Pittsburgh, Pa., plans boiler house at proposed new branch plant at Port Arthur, where site has been acquired. Project will comprise several units for production of polystyrene and components, used in manufacture of synthetic rubber, and is reported to cost about $6,500,000. Proposed to begin work soon.

Rhinelander, Wis.—Wisconsin Public Service Corp., Bellin Bldg., Green Bay, Wis., plans new hydroelectric generating station on Wisconsin River, near Rhinelander. Site has been selected on Menard Isle. Appropriation of $2,100,000 has been made for preliminary work in 1951, with main construction to begin in 1952.

Two 1250-psi, 950-FTT C-E-S radiant type boilers fired with pulverized coal or oil, each 400,000 pounds per hour. Soot blowing by steam, with air-powered long retractables, rotary units, wall blowers and air-heater blowers under Vulcan Automatic-Sequential Control.





Swings to VULCAN

Lights on boiler diagram show each boiler operates in correct sequence, for proper time. Centralized at panel, control is flexible for any operating need.

AUTOMATIC-SEQUENTIAL SOOT BLOWING at its new FRONT STREET STATION addition

Now using Vulcan on the 675 psi boilers at Front Street and Seward —and on 875-psi boilers at Warren —Pennsylvania Electric Company is swinging to Vulcan Automatic-Sequential Soot Blowers for the new 1250-psi Boilers in the Front Street Station addition at Erie, Pa.

Better boiler cleaning is sure, because blower operation will be positive and at proper intervals.

Steam will be saved, since each blower will operate for exactly the correct cleaning period and no more.

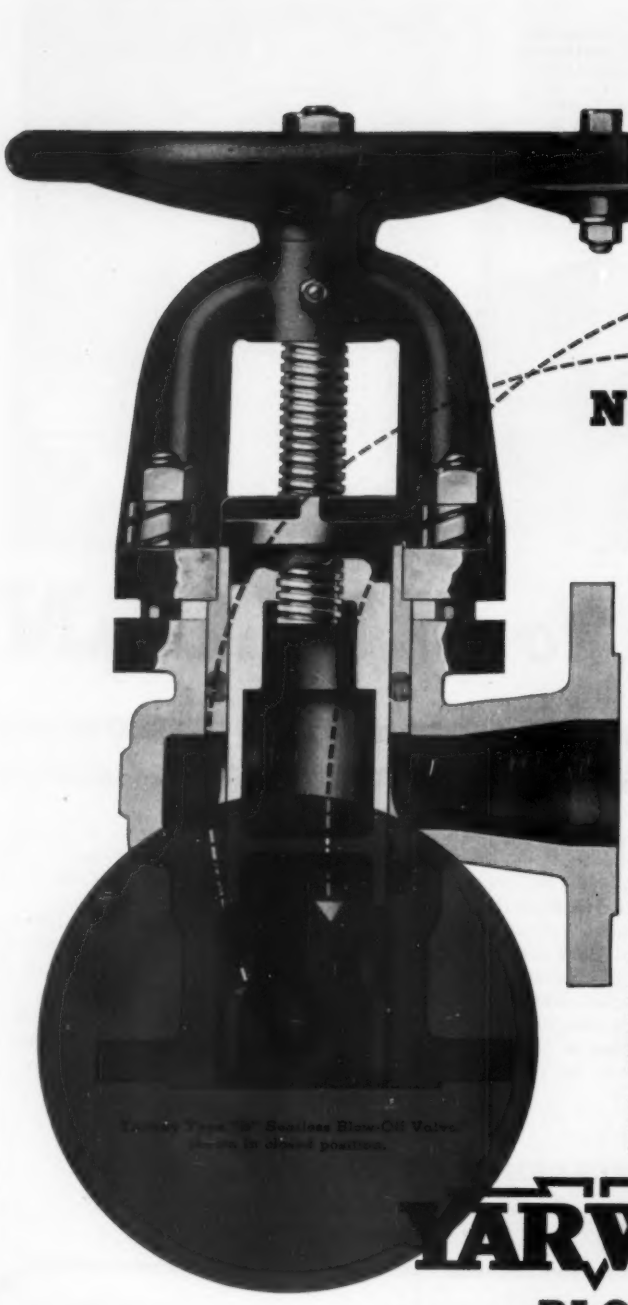
Time will be saved, for operators will start the sequential soot blowers from the panel—no need to climb to remote locations.

Operation will be dependable, for complete protective devices are provided for all units.

Get details in Bulletin 483

VULCAN SOOT BLOWER DIVISION
Continental Foundry & Machine Company
DU BOIS, PENNSYLVANIA

VULCAN *Automatic Soot* **BLOWERS**



WHAT?

NO SEAT?

● That's right! In this Yarway Blow-Off Valve there is no seat to score, wear, clog and leak.

The unique balanced sliding plunger design eliminates a common cause of blow-down valve trouble—the seat. Many boiler shut-downs are saved . . . power interruptions avoided . . . production speeded.

Latest metallurgical improvements also make Yarway the ideal blow-off valve for difficult service where acid washing is used.

Yarway Seatless Blow-Off Valves are available singly or in tandem combinations for all pressures up to 1500 psi. For higher pressures up to 2500 psi, specify Yarway Stellite-seat valves.

For the latest information on blow-off valves, get Yarway's newest catalog—B-424 for pressures to 400 psi, B-433 for higher pressures.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.
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YARWAY

BLOW-OFF VALVES

STOP BLOW-DOWN TROUBLES—KEEP BOILERS ON THE

LETTERS TO THE EDITORS

POWER PLANT LABORATORIES

A FEW COMMENTS and suggestions which are meant to be entirely constructive of the layout published by your fine magazine this month, April, 1951, titled, "A Power Plant Laboratory," by S. M. Sperry.

From the editor's box accompanying this article, you mention: "There are many smaller plants which could not justify so elaborate a laboratory."

Amen!

From the initial request published in your December, 1950, issue, a plea was made for information to equip a power plant laboratory for the routine analysis of water and lubricating oil. The routine analyses of water, including raw water supply; makeup; return condensate; boiler internal water; zeolite or other type softeners is a relatively simple matter. Through experimentation, the more it can be simplified, the more practical will be the end result.

Large water-treatment companies have extensive and often complicated lines of boiler-water testing equipment consisting of the essential test assemblies, solutions and complete instructions. However, much of this water-testing equipment and procedure is very time consuming and often left-to-go-until-tomorrow when the press of other mechanical emergencies arise.

From our experience in the Department of Corrections, which embraces all power plants, both large and small, in the Missouri State Prison System, consisting of 3000-kw diesel-plant; another 500-kw diesel plant; four large refrigeration plants; a 60,000-lb-per-hr modern boiler installation; a 30,000-lb hr installation; a 750-hp heating plant; three small 75-hp heating units, and more than 38,000 lineal-feet of return condensate lines, we have found that a simple, modified boiler-water testing procedure has paid off in every respect.

Boiler-tube and condenser-tube cleaning equipment is rapidly becoming dusty from lack of need and use. Pipe replacements are practically nil. Service factor and outage is equal to any other large manufacturing establishment and setup requiring large and assorted power-block and facilities.

We have at the present time the following procedure on boiler water tests:

A determination of Phenolphthalein Alkalinity.

A determination of Methyl Orange Alkalinity or total alkalinity reading.

A chloride determination for purposes of estimating boiler blowdown required; calculation of boiler water concentrations; boiler-water makeup content; softened water vs return condensate.

A regular hydrometer reading for the solids content.

In those plants using a phosphate treatment, we have a determination test showing the phosphate parts-per-million.

The above boiler-water tests are made daily on the boiler units; softener outlet; raw-water inlet; return condensate and makeup tanks. These tests are made every 24-hr usually at noon after peak loads. Results are usually forthcoming no later than 1 p.m. and treatment adjustments made as required.

Once a week on all waters, we run a standard silica test.

A pH test is made on boiler-waters daily to assure a pH of at least 10.5. A pH of 6.3 to 7.0 is maintained in the condensate lines and other power piping to prevent corrosion.

A constant record is carried on all tests and compared from day-to-day against load; makeup water added and total boiler-water treatment used.

I suggest that interested POWER ENGINEERING readers who contemplate the establishment of boiler-water testing facilities obtain the following practical publications:

BETZ HANDBOOK OF INDUSTRIAL WATER CONDITIONING, published by W. H. & L. D. Betz, Gillingham and Worth Sts., Philadelphia 24, Pa. Price $2.00 per copy. Starting on page 147 and continuing for 50 pages is every conceivable system of testing boiler and other power plant system waters. The first section of this publication contains detailed description of water and its mineral content; boiler operation; corrosion, and practically every possible eventuality that can occur in a boiler from incorrect water conditions.

MODERN pH AND CHLORINE CONTROL, by W. A. Taylor Company, 7300 York Road, Baltimore 4, Maryland. Ninth Edition, 1950. Gratis. Contains complete condensed descriptions and requirements for all water control tests and necessary test equipment. Packs in its terse explanations the required ppm chemical compounds required to prevent corrosion and assure dependable operation to all types of power equipment.

LAMOTTE CHEMICAL PRODUCTS COMPANY, Towson, Baltimore 4, Maryland. Publishes a very interesting and informative pH catalog of equipment and chemicals and accessory glassware for making all water tests in laboratories.

By reading these three publications, the average power-plant operator will gain a complete insight into the various control problems necessary.

In connection with the reader's request for lubricating oil analysis: this required testing procedure poses the following two conditions:

No. 1. The average oil analysis is very complicated, time consuming and when completed, requires thoroughly experienced and expert analysis.

No. 2. Equipment is bulky, expensive and has a very definite adjustment factor which must always be considered in relation to the particular application the various oils are being utilized.

The requirement for testing lubricating oil and analysis can be simplified by our procedure which was adopted three years ago and has proven entirely satisfactory. Regular monthly samples of lubricating oil are taken from diesel engines; other lubricated equipment and sent to a commercial firm for complete and detailed analysis.

THE FABER LABORATORIES, INC., 1313 West Randolph St., Chicago, Illinois, are one of the largest oil analysis laboratories in the country. They have branches at New York, Los Angeles, San Francisco and Seattle.

An average oil analysis costs $3.00 on a monthly basis, and the complete report is very simple and easy to grasp. It will show sludge; which adjustments are necessary either to oil addition or filters; accessories not functioning properly; remedy for effect of the operation has had upon the oil and to identify the amount and kind of abrasive wear and other contaminants. Usually they recommend this test every 30 days.

Faber have learned through their testing methods (many of which are their exclusive development) how much and what kind of metal may be found in equipment before abnormal wear occurs; how much dilution is allowable before an adjustment must be made; what kind and amount of water, emulsion, carbon, sand, or other abrasives and gum may be present before actual harm is caused.

These reports provide a complete grasp of maintenance required. In addition they offer insurance and proof for the power-plant operator for his superiors that he provides expert operation and maintenance of all equipment.

L. W. FITZPATRICK,
Chief Engineer,
Department of Corrections,
Jefferson City, Missouri.

Minimizing Hydrogen Leakage

The almost universal use of hydrogen-cooling of large rotating electrical machines has greatly improved the efficiency of these machines and, also, has provided many operating advantages. At the same time, this method of cooling has brought new problems of maintenance, one in particular, that of hydrogen leakage. In this article, Messrs. Snell and Morrison discuss this problem of leakage in a comprehensive and detailed manner and all operators of hydrogen-cooled machines should find it of unusual value

By D. S. SNELL and E. B. MORRISON
Turbine Divisions, General Electric Company

IN THE OPERATION of hydrogen-cooled electrical machines it is important to keep the amount of hydrogen leakage at a minimum. To achieve this requirement, it is necessary, first, that the machine be designed for minimum leakage, second, that care be exercised in its installation to ensure minimum leakage when the unit is placed in service, and finally, that means be provided for the convenient detection of hydrogen leaks that might develop.

The stator casings of all hydrogen-cooled machines built by the General Electric Co. are of welded plate construction, the individual welds being tested separately for gas-tightness. This is done by welding pipe nipples into each joint, at intervals, and applying 80 psi air pressure to the weld, soap water being used to detect leaks. With machines not requiring shaft seals—which include synchronous condensers and frequency converters—the flange joints of the stator casing are sealed against hydrogen leakage by a groove within the bolting line containing a ring of synthetic rubber. With generators the flanged joints of the stator casing and the horizontal joints of the end shields are sealed by grooves within the bolting line containing a viscous compound, which is forced into the grooves through external fittings with a pressure gun. When assembling the end shields to the stator, the joint surfaces are also coated with the compound, to further seal against leakage. The completed stator casing, with core assembled, is given an air pressure test at 38 psi, during which all joints are tested for leaks, first with soap water, for the larger leaks, then with the Type H leak detector (described later) for the smaller leaks. As soon as the apparent leaks have been corrected, the air supply is cut off and pressure readings are taken over a 24-hr period with a mercury manometer. From these readings, making corrections for temperature and barometric changes, and the casing volume, the leakage is calculated, as decribed in Appendix I. An air leakage, equivalent to a hydrogen loss of 20 cu ft per day at 0.5 psi pressure, is considered permissible for this test. Figure 1 shows the stator casing of a large hydrogen-cooled generator undergoing an air test in the factory.

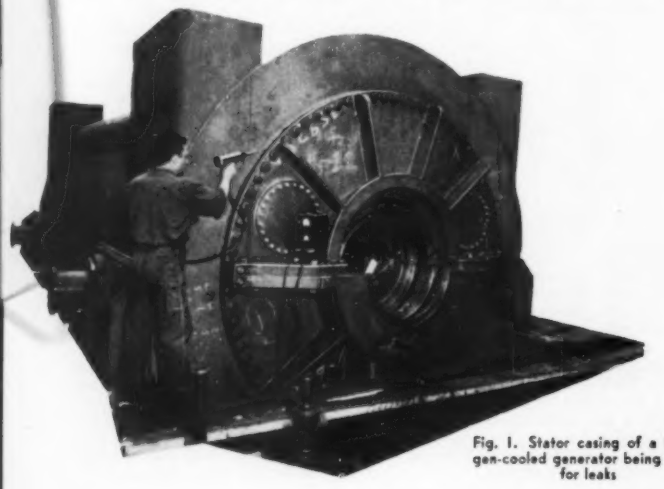

Fig. 1. Stator casing of a hydrogen-cooled generator being tested for leaks

The gas piping between the machine and the various auxiliaries is mainly of steel, with welded joints. To minimize leakage at valve stems, packless valves are used whenever possible. These valves are held open by a spring. A metal diaphragm isolates the valve stem from the valve seat mechanism so there can be no gas pressure on the valve stem. Clockwise motion of the valve handle causes a displacement of the diaphragm that closes the valve. When packless valves cannot be applied, valves with special stem packings are used. In the hydrogen control cabinet, the gas lines are of copper tubing, with brazed joints. The hydrogen manifold is made of brass, with brazed joints, and is given a 4000 psi hydraulic test at the factory.

Installation Procedure for Minimizing Hydrogen Leakage

To ensure low gas consumption in service, a careful installation job is essential. Welded and brazed joints in the gas system must be made with special care. Valves which must be welded or brazed into the piping must be dismantled before applying heat, to avoid distortion of the parts. Flanged joints must be uniformly tightened all around. All devices subject to gas pressure in service, e.g., valves, the liquid detector and and the seal drain enlargement (with generators) should be installed with a view to obtaining ready access for leak testing in service.

All gas lines are tested separately for leaks by closing the valves at the extremities and applying 80 psi air pressure through the drain opening

in Hydrogen-Cooled Machines

in each line. A pressure gage is installed between the air line and the line under test so that the drop in pressure in the latter with the air supply shut off may be read. The volume of the gas lines being small, an appreciable drop in the gage reading is required to indicate a relatively small leak.

An air pressure test at 15 or 25 psi is made on the machine and connected equipment, similar to the factory test, during which all joints in the machine casing and in the connected piping and equipment are tested for leaks. Then with the air supply cut off, pressure and temperature readings are taken over a period of at least 12 hr, from which the rate of air leakage and the equivalent hydrogen leakage is determined, using the charts, Figs. 2, 3, and 4 or the equations given in Appendix I. An equivalent hydrogen leakage at 0.5 psi pressure of 40 cu ft per day for generators and of 20 cu ft per day for other types of machines, as determined from the air test, is considered satisfactory.

Minimum Hydrogen Consumption Obtainable in Operation

It is frequently necessary to determine hydrogen consumption and to continue a leakage search with the machine in operation. Load demand may require placing a machine in operation before gas leakage can be reduced to a satisfactory minimum. Also, leaks may develop in operation, or as a result of faulty assembly following an outage. Before proceeding with leakage tests, an estimate of the minimum practical gas consumption obtainable should be made, to avoid continuing the leakage searches longer than necessary.

For types of hydrogen-cooled machines not requiring shaft seals, the loss of hydrogen in operation is due entirely to leakage, principally from joints in the casing; and since the peripheral length of these joints, which is a measure of the potentialities for leakage, is roughly proportional to the machine size, the minimum gas consumption for such machines may be given as some function of the rating. For G-E synchronous condensers, for example, the quaranteed hydrogen consumption at 0.5 psi ranges from 16 cu ft per day for a 15,000 kva unit to 30 cu ft per day for a unit of 75,000 kva. Experience indicates that these values are seldom exceeded, even in operation at 15 psi hydrogen pressure.

The hydrogen consumption for generators is necessarily larger than for the other types of machine, for, in addition to the loss by joint leakage, an additional loss occurs through the action of the shaft seals. Also, due to the construction of the end shields required for supporting the bearings, and the fact that a greater amount of auxiliary equipment is required, the potentialities for leakage are considerably greater with generators than with the other types of machine. For G-E generators in the larger sizes, the guaranteed values of hydrogen consumption are generally from 100 to 350 cu ft per day for pressures from 0.5 to 30 psi. For generators in the smaller sizes, lower values can be guaranteed.

For generators using a system of vacuum treatment for the sealing oil, the minimum hydrogen consumption, neglecting leakage, is represented by the loss by absorption in the oil. Taking the solubility of hydrogen in turbine oil at atmospheric pressure and operating temperature as 7 per cent, the absorption loss is given by the equation:

$$\text{Absorption loss} = 13.4\ p\ Q \text{ cu ft per day} \quad (1)$$

Where p = hydrogen pressure in atmospheres

Q = oil flow to gas side of shaft seals, gal per day

With generators using the "continuous scavenging system," through which the air carried into the gener-

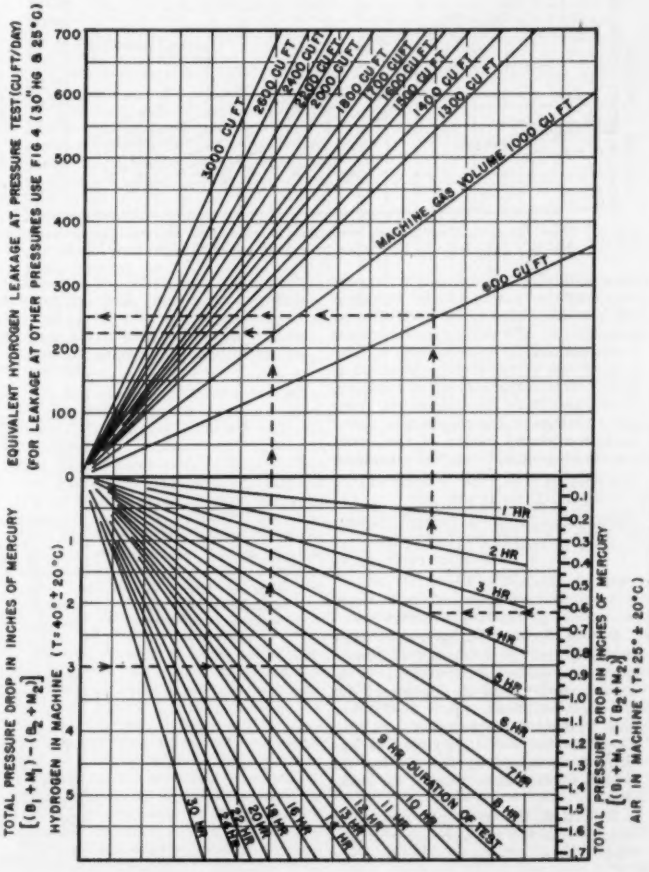

Fig. 2. Chart for calculating rate of gas leakage from a closed system from rate of pressure drop at constant temperature

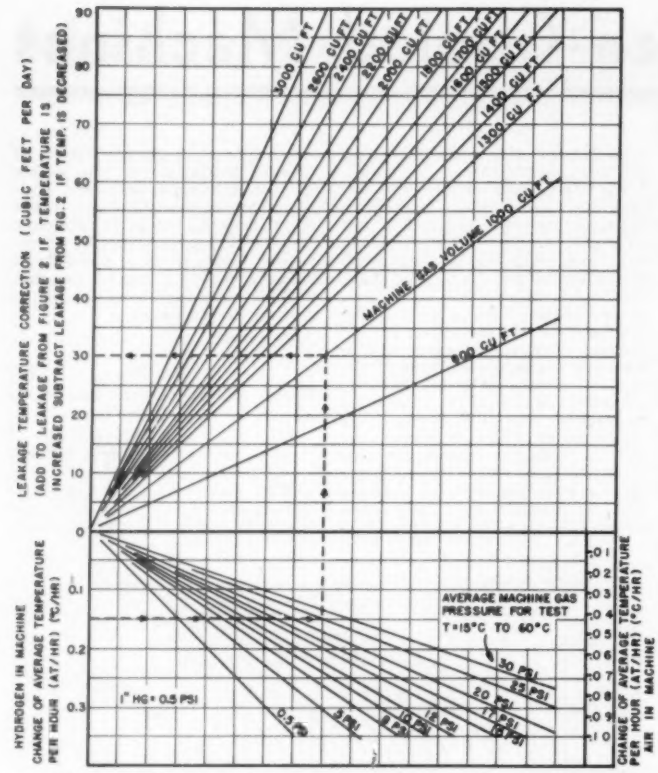
LEAKAGE TEMPERATURE CORRECTION (CUBIC FEET PER DAY)
(ADD TO LEAKAGE FROM FIGURE 2 IF TEMPERATURE IS INCREASED SUBTRACT LEAKAGE FROM FIG. 2 IF TEMP. IS DECREASED)
3000 CU FT
2800 CU FT
2600 CU FT
2400 CU FT
2200 CU FT
2000 CU FT
1800 CU FT
1700 CU FT
1600 CU FT
1500 CU FT
1400 CU FT
1300 CU FT
MACHINE GAS VOLUME 1099 CU FT
800 CU FT
HYDROGEN IN MACHINE
CHANGE OF AVERAGE TEMPERATURE PER HOUR (AT/HR) (°C/HR)
CHANGE OF AVERAGE TEMPERATURE PER HOUR (AT/HR) (°C/HR) AIR IN MACHINE
AVERAGE MACHINE GAS PRESSURE FOR TEST T=15°C TO 60°C
30 PSI
25 PSI
20 PSI
15 PSI
10 PSI
5 PSI
3 PSI
2 PSI
1 PSI
0.5 PSI
1" HG = 0.5 PSI

Fig. 3. Chart for calculating leakage error due to change in average gas temperature during leakage test. To be applied to leakage values obtained from Fig. 2

ator with the sealing oil is largely removed by continuously bleeding off a small quantity of hydrogen to atmosphere, the minimum hydrogen consumption is represented by the sum of the above loss by absorption in the oil and the loss by scavenging. The latter may be calculated from the readings of the scavenging flowmeters and the purity of the scavenged hydrogen, from the equation:

Scavenging loss (one flowmeter) = 0.051 KRZ, cu ft per day (2)

where K = purity correction factor for flowmeter

R = flowmeter reading, cc per min.

Z = purity of scavenged hydrogen, per cent

In Fig. 5, the hydrogen consumption is given for a number of generators at different hydrogen pressures, as obtained in operation. On the best machine, rated 30,000 kw, the hydrogen consumption is just equal to the calculated loss of hydrogen absorbed by the sealing oil, which means that there is no leakage.

In Fig. 6, the hydrogen consumption of a 25,000 kw generator at different gas pressures, before and after the correction of excessive leakage, is given. The calculated loss of hydrogen absorbed by the sealing oil is also shown. This gives an indication of hydrogen consumption with zero leakage. In some cases, the hydrogen loss before correction of excessive leakage has been sufficiently large to require limiting the load which could be carried, and also has made the cost of make-up hydrogen an item of importance.

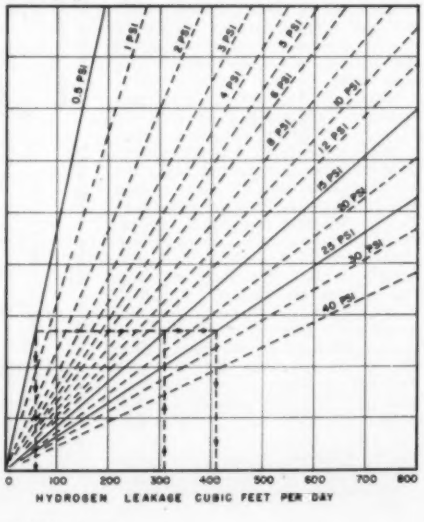

Fig. 4. Chart for calculating hydrogen leakage at different pressures

Methods of Leak Detection

In the following the principal methods of leak detection used with hydrogen-cooled machines are described and their fields of application defined:

(A) Soap Water

The most common method for detection of leaks in gas systems is to apply a solution of soap and water to the suspected leakage source, using a brush, the bubbling of the liquid indicating a leak. A specially-prepared solution of liquid soap, glycerin and water, with a thickening agent added, is used in factory testing of hydrogen-cooled equipment. The soap-water method has the advantage of indicating the size of a leak, as well as localizing it. However, it will not readily detect very small leaks, and can be used only when the parts are fairly accessible, and where the suspected leak can be completely covered with the liquid.

(B) Flammable Gas Detector

With hydrogen in the machine, this instrument is highly effective for finding leaks in the gas system. Several makes of this type of instrument are available. Since they are designed for portability, and may be used with a long probe, when necessary, these devices may be used for leak detection in practically any part of the gas system. Although their use ordinarily requires that the tip of the instrument probe be held close to the surface

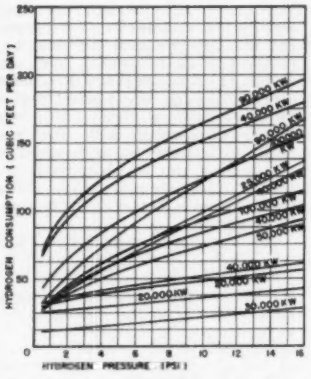

Fig. 5. Hydrogen consumption at different hydrogen pressures for several generators

being investigated, their high sensitivity frequently permits detection of a leak at some distance directly above it, if the air is still. This feature is frequently advantageous in locating leaks in parts which are relatively inaccessible.

(c) Type H Leak Detector

This instrument, an electronic device developed by the G-E Research Laboratory, has been in use in the factory testing of all hydrogen-cooled equipment for the past three years, and is becoming widely used in installation and service testing as well. Its operation and use have been described in articles which have appeared in the technical press.[1] It may be used with either air or hydrogen in the machine (although certain precautions must be observed in its use in areas containing hydrogen), and requires for its operation the introduction of a small amount of halogen gas into the system.

As illustrated in Fig. 1, the Type H Detector consists of a control unit and a detector unit, which are connected together with a length of cable. The detector unit is a hand-held probe with a pistol grip and a flexible metal nozzle with plastic tip. It contains an element which is sensitive to halogen compound vapors, and a blower which draws air into the detector unit. An ammeter in the back of the detector unit indicates the current through the detector anode. The control unit is supplied from 115 v, a-c. In testing for leaks the nozzle of the probe is held about ½ in. from the surface being explored and is moved at the rate of about ½ in. per sec. As the nozzle passes a leak, halogen vapor is drawn in, and as the vapor reaches the element an increase in current is indicated on the ammeter.

[1] Electronics Simulates the Sense of Smell by W. C. White and J. J. Hickey, *Electronics*, May 1948, P. 110.

How to Test for Leaks Reliably, Quickly, and at Low Cost by J. R. Neff, *General Electric Review*, Oct. 1949, P. 41.

The halogen gas used in testing hydrogen-cooled equipment with the Type H Detector is freon 12, this gas being inert, non-toxic and readily obtainable. About one pound of freon is used for every 500 cu ft of system volume, at atmospheric pressure, this proportion being sufficient to permit detection of a leak amounting to as little as one (1.00) ounce per year. Since freon is heavier than air, it tends to diffuse downward when escaping from a leak; hence the probe should preferably be held below the suspected source of leakage. The detector cannot be successfully used if there are traces of halogen gas in the room air; hence if such traces are detected, a fan should be employed to remove them. The halogens include chlorine, bromine, iodine and fluorine, some of which may be present in the atmosphere of a plant, or contained in some of the compounds used in the assembly of a machine.

(d) Odorants

An odorant injected into the gas system of a machine will frequently reveal the general area of a leak, after which it may be traced to its source by the use of one of more of the methods given above. If a Type H Leak Detector is available, however, the use of an odorant will seldom be required as this instrument, due to its extreme sensitivity, will indicate a leak at an appreciable distance from the source nearly as well as an odorant. The odorants commonly used in leak detection with hydrogen-cooled machines are ether and Captan, the latter being a commercial odorant used in odorizing natural gas. About one pint of ether or two ounces of Captan will effectively odorize 1000 cu ft of system volume. The odorant may be introduced through either of the two gas manifolds; using either hydrogen or CO_2 pressure to discharge it into the machine, if there is hydrogen in the casing, or using air pressure if the casing is filled with air. Opening the various vent valves in the gas system will indicate when the gas in the machine has become sufficiently odorized. Care must be used in handling odorants to avoid getting them on the hands of clothing, or on exposed parts of the equipment; otherwise their effectiveness for leak detection will be vitiated.

Evaluation of Leaks

Having located a leak, using one or more of the above methods, an estimate of its size should be made, in order that the time available for the leakage search may not be dissipated in correcting minor leaks, but may be more profitably spent in locating and correcting the major leaks. Also, if a sizeable leak is found, an accurate measure of its size will frequently show it to be the main leakage source, making further searches unnecessary. Although continued experience with either of the two leak-detecting instruments described above will enable the operator to judge the approximate size of the leak from the reading of the instrument, the great sensitivity of these devices often causes a relatively small leak to appear important; hence supplemental means for evaluation of leaks are usually required.

Soap water applied to a leak usually gives a good indication of its size, from the size and rate of formation of the gas bubbles. On inclined surfaces, to which a soap solution may not readily cling, "glyptal" pipe compound is frequently effective in evaluating leaks, this compound being both adhesive and elastic. A leak at a flanged joint may be evaluated by first wrapping friction tape around the joint, then piercing the tape at one point and applying soap water or "glyptal" to the opening.

It is often useful to build a partial enclosure around the leak, using asbestos putty or similar material, then to fill the enclosure with water or oil and note the size and rate of formation of the gas bubbles. The volume of a spherical bubble being $4\pi r^3 \div 3$, where r is the bubble radius, an estimate of the size of the

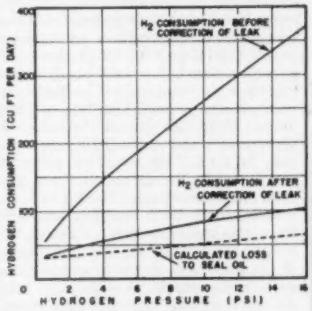

Fig. 6. Hydrogen consumption for a 25,000 kw generator before and after correction of excessive leakage. Calculated loss to seal oil corresponds to zero leakage

bubbles and a count of their rate of formation will usually permit a fairly accurate estimate of the leakage.

Sometimes it is possible to improvise an enclosure completely enclosing the leak, permitting the leakage to be passed through a measuring instrument. One of the flowmeters at the hydrogen control panel has often been used for this purpose. (Multiply scale reading by 0.263 if air is being measured, and multiply cc per min by 0.051 to obtain cu ft per day.) Also a displacement meter may be improvised for such a measurement, by filling a glass container of known volume with water, inverting it in a pail of water with the mouth just below the water surface, then inserting the free end of

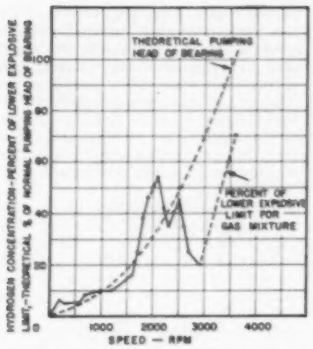

Fig. 7. Hydrogen concentration in bearing drain of 25,000 kw generator measured at different speeds

a tube from the enclosure up into the container and timing the rate of displacement of water from the container.

Procedure Followed in Leakage Investigations

Although, as previously shown, efficient methods and means for leak detection are available, searching for hydrogen leaks is frequently an arduous and time-consuming task—appearing not unlike "searching for a needle in a haystack"—hence an efficient procedure in leakage investigations is essential. A procedure which has been found effective in numerous leakage investigations—particularly in those made after placing a machine in service—is the so-called "segregation method," by which a pressure test is made on the entire gas system, with first one section of the system, and then another, isolated from the machine itself through the closing of valves in the gas piping at the machine. A curve of gas pressure in the machine with time, with the gas supply cut off, is plotted: also readings of temperature and barometric pressure are taken. If the slope of the pressure-time curve—with the temperature and barometric pressure substantially constant—does not change significantly, as the various sections are isolated from the machine, one by one, then the leakage may be assumed to be in the machine itself or in those sections of the gas system which may not be isolated from the machine. If, however, the pressure-time curve shows a significant decrease in slope following the isolation of a given section, an appreciable leak in the section isolated is indicated. Calculation of the rate of hydrogen loss from the rate of gas pressure drop, using the charts, Figs. 2 and 3, or eq. (4), Appendix I, will indicate the magnitude of any change in the leakage rate obtained during the test.

The above test should be made, preferably, with the machine inoperative; however, by the exercise of proper care that the normal operation of the machine is not impaired, it can also be made with the machine in service. In the latter case, operation at a practically constant load is desirable to avoid having the gas pressure influenced by changes in temperature. Readings of gas pressure should be taken with a mercury manometer. (Note: 1 in. mercury = 0.5 psig).

During the test, the sections of the system remaining under pressure should be systematically explored for leaks; then, when the section or sections in which the major leakage is present have been determined (from analysis of the pressure-time curve), the search for leaks may be concentrated on these sections.

Possible Sources of Hydrogen Loss

The various sections of the gas system of a machine which must be considered in any leakage investigation, together with the potential leakage sources in these sections, are indicated in the following. Where special means for leak detection in the section have been provided in the design, these are indicated.

(1) The machine casing. Leakage sources include: Flanged joints between end shields and casing, between casing sections, and between end shield sections. (Joint leakage may be detected at bolt heads as well as at joints, hence all flange bolt-heads must be checked); gasketed cooler joints; terminal board joints with frame, and terminal bushings; packing glands for temperature detector leads; thermometer wells; screwed or welded joints between gas piping and casing.

(2) Seal drain piping, drain enlargement, and hydrogen detraining tank (with generators). All parts in this section which are above the oil level are under gas pressure. This section, except for the hydrogen detraining tank, may not be isolated from the machine.

(3) Hydrogen control cabinet. All equipment under gas pressure in this section may be isolated from the machine. Leakage sources include: compression pipe fittings; valve stems; gas analyzer cells and filters.

(4) Auxiliary machine gas pressure gage. This may be isolated.

(5) Gas piping under the machine and the connected auxiliary equipment, including gas manifolds, liquid detector, gas dryer and seal drain alarm. (The last two items are provided only with generators.)

(6) Valve in purging vent line. A test opening in vent line permits detection of leakage past the valve.

(7) Field terminals (with generators).

(8) Space in outer end shield (of generators). Leakage into this space may occur (a) through the shaft seal due to insufficient oil pressure; (b) through the gasketed joint between the seal housing and end shield; (c) through the seal housing; or (d) through the welded pocket in the bottom section of the end shield, connecting with the seal drain. A test opening is provided in the bearing cap which permits detection of leakage into the end shield space, using a detecting instrument or an odorant.

(9) Vacuum treating system (with generators). A measurement of the amount of hydrogen discharged from the vacuum pump should correspond approximately to the estimated loss of hydrogen by absorption in the sealing oil. If an amount in excess of the absorption loss is indicated, a direct leak between the hydrogen-detraining and vacuum tanks is indicated; this could be the result of improper operation of the float in the former tank.

(10) Scavenging flowmeters (with generators). Loss of hydrogen through these instruments may be calculated, using eq. (2).

Of the various methods for leak detection previously described, the use of either the flammable gas detector or the Type H Leak Detector is the most effective for all the sections of the gas system where leaks may occur; while in several sections, particularly sections (6) to (9), other methods may not be as conveniently used. Leakage in section (7) may be detected either with one of these devices, or with an odorant.

To obtain the hydrogen loss through section (9) the measured rate of gas discharge from the vacuum pump should be multiplied by the percentage of hydrogen in this gas. The discharge rate may be measured with a gas meter or an improvised displacement meter, or may be calculated approximately from the equation:

$$\text{CFM discharged} = 0.027 \times (\text{Pump capacity, CFM}) \times (\text{Abs. Press. in Vac. Tank, ins. Mer.}) \quad (3)$$

The hydrogen content in the discharged gas may be obtained by chemical analysis, by use of a flammable gas detector provided with a dilution valve, or with the gas analyzer at either the hydrogen control or purging control panels. The latter, when so used, must first be calibrated from hydrogen-air mixtures, using the hydrogen-CO_2 scale.

Some Field Experiences in Leakage Detection

To illustrate the use of the methods and procedure for leak detection described above, a number of investigations of excessive leakage on hydrogen-cooled generators have been summarized in the following. The examples given have been selected from a number of similar investigations, as representative of various types of leakage problems which may be encountered; also to show

the difficulty of establishing general rules for leak detection that will apply in all cases, the many possible sources of leakage making it necessary to study each problem separately and apply methods of leak detection which appear best adapted to the problem at hand.

(A) TWO-POLE, 25,000 KW GENERATOR

After several years of operation with a satisfactory gas consumption, a new collector-end bearing was installed, following which the consumption in operation increased to about 400 cu ft per day at 0.5 psi pressure; also, hydrogen could be detected in the collector-end bearing drain. At standstill, however, normal gas consumption was obtained and no hydrogen could be detected in the bearing drain. A test was made, using the flammable gas detector, to determine the hydrogen concentration in the drain line at different speeds, with the results shown in Fig. 7. A curve of theoretical pumping head of the bearing (assuming 100 percent at rated speed) is shown in Fig. 7 for comparison with the curve of hydrogen concentration. A marked similarity in the shape of the two curves is noted, except for the pronounced dip in the curve of hydrogen concentration at speeds between 2100 and 2900 rpm. This region being that of the first critical shaft speed, at which some change in the pumping action of the bearing might be expected, it was deduced that the presence of hydrogen in the drain line was due to bearing suction, acting through the bearing feed line within the bearing upon an internal void communicating with the hydrogen atmosphere. The shaft seals of this generator being of a type built integral with the bearing, such a condition was considered possible. To correct this condition, the orifice was removed from the bearing feed line outside the bearing and relocated at the horizontal joint of the bearing, thus removing the suction of the bearing from the feed line. Following this change the hydrogen consumption in operation fell to about 50 cu ft per day, at 0.5 psi pressure, indicating that the above analysis of the trouble had been correct.

(B) TWO-POLE, 35,000 KW GENERATOR

Although the leakage test at installation had been satisfactory, a gas consumption of about 500 cu ft per day was obtained in operation at 9 psi hydrogen pressure. With the generator in operation at constant load a leakage test was conducted, readings of gas pressure being taken as shown in Fig. 8. Readings of gas temperature and barometric pressure were also taken; their variation however, was slight, so that the slope of the pressure curve gave a good indication of the hydrogen consumption. An odorant (Captan) was introduced into the gas system at the start of test. From the pressure-time curve a gas consumption of 470 cu ft per day at 9.3 psi was indicated with the vacuum system operative. To determine if excessive hydrogen loss might be occurring through the vacuum system, the latter was shut down and the shaft seals were supplied from the bearing oil header. Referring to Fig. 8, this change caused a change in the slope of the pressure curve, corresponding to a reduction in gas consumption of about 137 cu ft per day. However, measurements of the seal oil flow indicated that this difference could be approximately accounted for by the calculated amount of air brought into the generator with the sealing oil with the seals supplied with untreated oil. Also, a measurement of the amount of hydrogen discharged from the vacuum pump—using a gas meter for flow measurement, and the gas analyzer at the hydrogen panel for measurement of the hydrogen content—indicated a hydrogen loss not much greater than the calculated loss by absorption in the sealing oil.

The odorant indicated a leak at the hydrogen detraining tank, which was traced to the gasketed joint of the oil level alarm, using a flammable gas detector. To evaluate this leak, the hydrogen pressure was lowered to 7 psi, which allowed the detraining tank to fill, covering the leak. An abrupt decrease in the rate of gas pressure drop was obtained, as shown in Fig. 8, which was evaluated to show that a leak of about 200 cu ft per day at 9 psi pressure had been obtained at the above point. With this leak corrected, the vacuum system was restored to operation and the leakage test continued. An overnight test indicated a gas consumption of about 255 cu ft per day at 8.5 psi, which was still excessive. To check for leakage through the shaft seals, the seal oil pressure was increased. An abrupt decrease in the drop in gas pressure was noted, as shown in Fig. 8, indicating that leakage has been occurring through the shaft seals. Checks with the flammable gas detector indicated leakage through the turbine end seal. A test was made, using the detector, to determine the per cent explosibility of the gas mixture in the bearing drain at different differential seal oil pressures, with the results shown in Fig. 9, indicating that the seal pressures previously maintained had been too low to prevent leakage through the seals.

Subsequent inspection of the turbine-end seal indicated a slight misalignment, which had caused excessive oil flow at elevated gas pressure, resulting in an abnormal pressure drop in the seal feed passage which in turn had reduced the differential oil pressure at the shaft available for a seal. With this error corrected, the hydrogen consumption in operation fell to about 150 cu ft per day at 9 psi pressure.

(C) TWO-POLE, 40,000 KW GENERATOR

After a few weeks of service, excessive gas leakage was obtained in operation at elevated hydrogen pressures. Investigation with a flammable gas detector showed a 20 per cent explosive mixture at the test opening in the bearing cap at turbine end. With the differential seal oil pressure doubled, no reduction in the per cent explosibility of the mixture at this point was noted, indicating no leakage through the shaft seals; hence leakage in section 8 (b), (c), or (d) was indicated. To evaluate this leak, an estimate of the amount of hydrogen discharged from the vapor extractor through the roof vent was made. From a measurement of the hydrogen content of the gas discharged, using

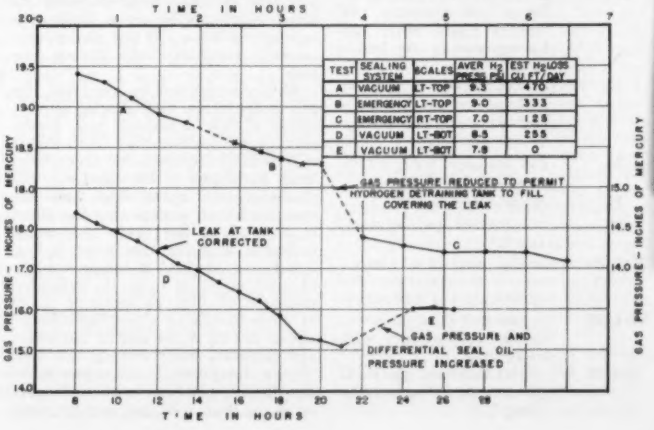
TIME IN HOURS
GAS PRESSURE - INCHES OF MERCURY
TEST | SEALING SYSTEM | SCALES | AVER H2 PRESS PSI | EST H2 LOSS CU FT/DAY
A | VACUUM | LT-TOP | 9.3 | 470
B | EMERGENCY | LT-TOP | 9.0 | 333
C | EMERGENCY | RT-TOP | 7.0 | 125
D | VACUUM | LT-BOT | 8.5 | 255
E | VACUUM | LT-BOT | 7.9 | 0
GAS PRESSURE REDUCED TO PERMIT HYDROGEN DETRAINING TANK TO FILL COVERING THE LEAK
LEAK AT TANK CORRECTED
GAS PRESSURE AND DIFFERENTIAL SEAL OIL PRESSURE INCREASED

Fig. 8. Variation of hydrogen pressure with time in leakage test on 35,000 kw generator with hydrogen supply cut off

a flammable gas detector provided with a dilution valve, and a visual estimate of the velocity of discharge from the roof vent, a hydrogen loss of about 300 cu ft per day through the vapor extractor was calculated. This amount was of the order of magnitude of the total hydrogen consumption, indicating that the main source of leakage had been found. With the generator shut down and the bearing cap and bearing removed, (hydrogen pressure being maintained in the generator), investigation with the flammable gas detector failed to indicate the source of leakage. The bearing drain opening in the end shield was then plugged and the lower section of the shield filled with oil. Bubbling of the oil indicated the source of leakage to be a defective weld in the seal drain pocket. (The relative inaccessibility of the leak made detection with an instrument difficult, hence the above method of leak detection was the most practical in this instance.) With this leak corrected by welding, the hydrogen consumption of the generator was reduced to the normal value. The above leak had apparently opened up in service, the initial air leakage test on the generator having been satisfactory.

APPENDIX I
FORMULAS AND CHARTS FOR CALCULATING HYDROGEN LEAKAGE

The rate of gas leakage from the machine during a leakage test may be calculated from the following equations:

$$L_a = 238\frac{V}{H}\left[\frac{B_1 + M_1}{273 + T_1} - \frac{B_2 + M_2}{273 + T_2}\right] \quad (4)$$

$$L_h = 3.75\, L_a \quad (5)$$

where

L_a = gas leakage, cu ft per day at atmospheric pressure referred to a temperature of 25 C and a barometric pressure of 30 in. of mercury. If test is made with air, L_a represents air leakage.

L_h = equivalent hydrogen leakage at test pressure and 98 per cent purity (cu ft per day).

L_a = gas leakage, with air in machine (cu ft per day).

H = duration of test (hr.).

V = volume of gas system, (cu ft).

B_1 & B_2 = initial and final barometric pressures, respectively (in. mercury).

M_1 & M_2 = initial and final gas pressures, respectively (in. mercury).

T_1 & T_2 = initial and final gas temperature, respectively (deg C).

The charts, Fig. 2, 3, and 4, may be used to determine hydrogen leakage instead of equations (4) and (5), if the temperature does not vary more than 0.35 C per hr during the test. Although Fig. 2 has been prepared for assumed air and hydrogen temperatures of 25 C and 40 C respectively, the error in using the chart for gas temperatures ± 20 C from these values is less than 10 per cent.

With the machine at standstill, the temperature in the machine remains fairly constant, hence the leakage in a test at standstill may usually be determined by reference to Fig. 2 alone. From readings of barometer and machine gas pressure, the absolute pressure drop with air in the machine is determined. Entering Fig. 2 at the lower right hand ordinate, a horizontal line is drawn to intersect the line corresponding to the duration of the test. From this

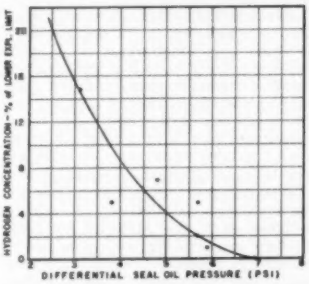

Fig. 9. Hydrogen concentration in bearing drain of 35,000 kw generator measured at different values of differential seal oil pressures

intersection, a vertical line is drawn to intersect the line corresponding to the volume of the machine. The latter intersection gives the equivalent hydrogen leakage for the average test pressure. The example given in Fig. 2 indicates that for a casing volume of 600 cu ft, a drop in air pressure of 0.63 in. of mercury in 4 hr corresponds to a hydrogen leakage of 250 cu ft per day at the average pressure held during the test.

With the machine in operation, the gas temperature may change appreciably during a leakage test, hence leakage values obtained from Fig. 2 will usually require some correction. With hydrogen in the machine, the procedure for using Fig. 2 is the same as for air except that the chart is entered at the lower left hand ordinate. The example given in Fig. 2 indicates that for a casing volume of 1000 cu ft, a drop in hydrogen pressure of 3 in. of mercury in 10 hr corresponds to a hydrogen leakage of 225 cu ft per day at the average pressure held during the test. If the temperature changes more than 0.05 C per hour with hydrogen, or more than 0.02 deg per hr. with air, a temperature correction must be applied from Fig. 3. Entering this chart with the rate of change of temperature in C per hr., (using the left hand ordinate for hydrogen, the right hand ordinate for air) draw a horizontal line to intersect the line corresponding to the test pressure. From this intersection draw a vertical line to intersect the line corresponding to the machine gas volume. This gives the correction that must be applied to the value of equivalent hydrogen leakage obtained from Fig. 2. The example given in Fig. 3 indicates that for a casing volume of 1000 cu ft filled with hydrogen, and a test pressure of 25 psi, a rate of change in average temperature of 0.15 C per hr requires a correction value of 30 cu ft per day. This correction is to be added to the hydrogen leakage obtained from Fig. 2 if the temperature has increased or subtracted if the temperature has decreased.

To determine the equivalent hydrogen leakage at some pressure other than the test pressure Fig. 4 may be used. This chart applies for leakage only, hence if leakage from a hydrogen-cooled generator is being calculated, the hydrogen loss by absorption in the sealing oil (for generators using the vacuum system) or the hydrogen loss by scavenging (for generators using the continuous scavenging system) must first be deducted from the equivalent hydrogen leakage determined from Fig. 2, to determine the actual hydrogen loss by leakage. Entering the base of the chart with this value of leakage draw a vertical line to intersect the line corresponding to the test pressure. At this point draw a horizontal line. Where this line intersects another pressure line, draw a vertical line and this will give the leakage for that pressure. The example given in Fig. 4 indicates that for an equivalent hydrogen leakage of 300 cu ft per day at 15 psi, there would be a leakage of 58 cu ft per day at 0.5 psi and a leakage of 410 cu ft per day at 25 psi. To the leakage loss must be added the estimated scavenging rate on seal oil absorption for that pressure to obtain the equivalent hydrogen consumption for a generator.

EXECUTIVE ENGINEER WANTED

A WELL-KNOWN firm of consulting engineers has asked us to help them find a college educated power plant executive engineer to operate a 600 psi, 750 F boiler plant and a 5000-kw, back-pressure turbogenerator. He must have had similar experience in other plants and must be familiar with the installation and operation of such equipment and auxiliaries. He should be somewhere around 35 to 40 years old. This plant serves a paper mill. Located within a reasonably short distance from New York City. If you are interested, please write to the Editor, *Power Engineering*, 110 South Dearborn St., Chicago 3, Ill.

Volga Hydroelectric Projects—Bigger'n Anything!

Soviet Union plans big hydroelectric projects on the Volga—to hear them tell about it. The two projects referred to in this article, if completed, would have a combined capacity of 3,700,000 kw

ON 20TH AUGUST 1950 the Soviet Council of Ministers, meeting under the chairmanship of Deputy Premier Molotov, passed a decree providing for the construction at Kuibyshev on the middle Volga of a dam and power station with a capacity of 2,000,000 kw. The decree, which was given a propaganda build-up astonishing even by Russian standards, has seven clauses:

1. The Hydro-electric station will be bulit in the Kuibyshev urban district and will have a capacity of approximately 2,000,000 kw with an annual output of approximately 10,000,000,000 kwh.

This, according to the figures here given, figures out to be equivalent to operation at about 59 per cent load factor.—Ed.

The station will be working to full capacity by the end of 1955.

2. The hydro-electric station will be instrumental in irrigating 1,000,000 hectares of land along the Volga.

A Hectare equals 2.471 acres, so this, translated, means about 2½ million acres.—Ed.

3. The dam will carry a new railway across the Volga.

4. Power from the Kuibyshev station will be distributed as follows: 6,100,000,000 kwh to Moscow; 2,400,000,000 kwh to Kuibyshev and Saratov and 1,500,000,000 kwh to the region beyond the Volga.

5. The construction of the hydro-electric station will be carried out by a new organization to be known as Kuibyshev-Gydro-Stroy of which I. V. Komzin will be Director and N. E. Shaposhnikov chief construction engineer.

6. The preliminary survey will be carried out by S. Y. Zhuk, Head of the 'Gydro-Proeekt' organization.

7. Plans for the building of high-tension lines to distribute power from the station will be drawn up by the Ministry of Agriculture which will also take into account the power requirements of agriculture in this area.

S. Zhuk, the engineer in charge of the preliminary survey work (reputed to be one of the most brilliant "back-room boys" in Soviet industrial planning), next day said in an interview over Moscow Radio that the new hydro-electric station would surpass in size the Boulder Dam plant in the U.S. and will generate more than three times as much power as the Dnieper Hydro-Electric station.

Comrade Zhuk evidently has not heard that the name of Boulder Dam has been changed back to Hoover Dam. At the present time, Hoover Dam plant has an installed generating capacity of 1,034,000 kw. Also, comrade Zhuk conveniently ignores our bigger Grand Coulee.—Ed.

Referring to the steps taken since the war to harness the Volga waters and to the construction of power stations at Ivankovo, Uglich and Shcherbakov, Zhuk pointed out that the new station would be the first one on the middle reaches of the Volga where the river flowed through the arid zone. In conjunction with powerful pumps, through which the Volga waters would be raised into vast reservoirs, it would play an important part in Stalin's plan for transforming dry steppes beyond the Volga into new granaries. The dam and reservoirs would open up thousands of miles of the Volga and Kama rivers to large vessels, besides making it possible to regulate the flow of water so as to maintain navigation between Kuibyshev and Astrakhan (where the Volga reaches the Caspian Sea) for the largest vessels. The output of the Kuibyshev station, Zhuk said, would be greater than that of the 30 power stations built during the first 15 years of the Soviet regime.

A model of the dam and power station on a scale of 1:340 inches occupying 600 square meters in the grounds of the Moscow Institute of

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Here is a most interesting report on some of Russia's recent plans for hydro projects on the Volga River. It was compiled especially for *Power Engineering* by Universal Trade Press Syndicate representatives in Europe under the direction of Herbert Weil from statements made in Russian publications and radio broadcasts readily available there. There is nothing secret about them; often they can be secured in translation in this country. But when even the Soviet *engineering* has to follow a Marxist ideology, some of the claims become really funny. Now, of course, if this were all just so much good-natured rivalry between two great countries to raise their own living standards, it would be all to the good, but we know that is not the purpose. Perhaps if we used the right methods we could convince the Russians that we, at least, have that objective, rather than war. We are so far ahead of the Russians in power development that their pretensions are a bit ludicrous. All you have to do is to compare the figures for the two countries. Their own statements are no doubt exaggerated; moreover, they are all *plans*. Our figures show what we already *have*, in addition to what we plan. By editorial comment at appropriate points, we have tried to make these comparisons. Again, remember that this is what *they* say. It's full of their own propaganda. Neither our own reporters nor we put it there.

This is a report of statements by Russians, who are either completely ignorant of the power developments in the United States or else deliberately misrepresent them to make their own achievements look bigger. In a way it is fun to go through a report like this, making smart cracks and pointed notes, as the editors have done, but it ain't funny because all the inaccuracies and propaganda cracks indicate that the Russians realize their shortcomings regarding power and are trying desperately to build up their facilities.

Energetics shows the power station on the right bank of the river and two series of shipping locks close to the left bank. A reinforced earthwork dam running out from the station is to be continued across the river by a concrete dam of 48 sections, each with a sluice.

Second Project at Stalingrad

A second project for harnessing the Volga's waters was published in a Government decree of 30th August. This provided for the building of a dam and power station at Stalingrad which would, among other things, result in the opening-up of large semi-arid regions on either side of the Volga. The main provisions of this decree were:

1. The hydro-electric station will be built in the Stalingrad urban district; it will have a capacity of 1,700,000 kw with an annual output of 10,000,000,000 kwhr. Construction is to begin in 1951 and the station will be working at full capacity by the end of 1956.

2. The power output of the Stalingrad station is to be distributed thus: 4,000,000,000 kwhr to Moscow; 1,200,000,000 kwhr to the Central Black Earth Provinces; 2,800,000,000 kwhr to Stalingrad, Saratov and Astrakhan provinces; 2,000,000,000 kwhr to the North Caspian region and the area beyond the Volga.

3. A "Stalingrad Main Canel" will be built to convey water without pumping from the Stalingrad reservoir for the irrigation of 6,000,000 hectares [14½ million acres] of land in the Northern part of the Caspian plain. Canals will also be built in the Black Earth region and the Nogai Steppe.

4. To supervise the Stalingrad hydro-electric project a new organization will be set up: the Stalingrad-Gydro-Stroy with F. G. Login as Director and S. R. Medvedyev as Chief Engineer.

5. The preliminary survey for the hydro-electric station and the principal canals will be carried out under the direction of S. Y. Zhuk of "Gydro-Proekt" organization.

6. Plans for the distribution grid will be drawn up by the Ministry of Power Stations.

High Voltage Transmission

Writing recently in the periodical Planovoye Khozyaistvo, Zhuk stated that turbines of unprecedented size would be installed at the Stalingrad and Kuibyshev stations. The total weight of the equipment of the two plants would be about 120,000 tons. Furthermore a large number of high-voltage cables would be laid including the two main lines Kuibyshev-Moscow and Stalingrad-Moscow, each 1240 miles long, which would transmit power at a potential of 400,000 v, "twice the normal voltage and higher than that used anywhere else in the world."

400,000 volts! Yeah? How about Sporn's experimental 500,000-v line at Brilliant, Ohio?—Ed.

Over 1200 miles of 220,000 v, power cables would also be laid. Zhuk was at pains to point out the contrast between this potential achievement and conditions in the U.S. where, he said, there were no power cables longer than 430 kilometers.

True, the Hoover Dam-Los Angeles line, which is 270 miles long (equivalent to about 430 km) is probably the longest high voltage power line in this country, that is, as a single transmission unit. The Russian statement, however, fails to take into account our vast interconnected systems, which, if need be, provide connected power transmission facilities from Boston to the Mississippi River.—Ed.

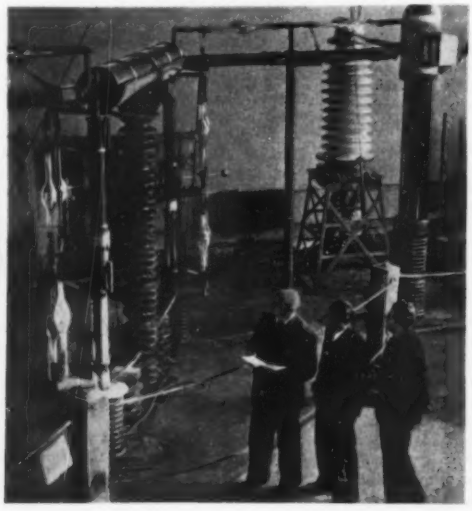


Fig. 1. View taken at the Kalinin Institute for Poly-Technics in Lenningrad, showing experimental setup used in developing long distance grid equipment for the Kuibyshev project

Fig. 2. The poster shown in this picture, taken at the Dynamo Machine Building Works at Moscow, says, "We are completing an order for the great projects on the Volga"

Some of the water needed for irrigation in the Volga region would have to be pumped from the stations to an average height of 150 ft and in some places as high as 300 ft.

Much of the generating plant for the two projects is to come from the "Elektrosila" works at Leningrad which has supplied equipment for every power station in the USSR in recent years. According to the works' Chief Designer, the generators designed for the Kuibyshev station would have a "clearance capacity" (gabaritovaya moshnost) twice as great as "the world's biggest generators"—those built by "Elektrosila" for the Shcherbakov power station. One of the basic components of the new generating plant, the so-called footstep-bearing (podpyatnik), would be subject to a pressure of 4000 tons.

Arkangelsky, who has been placed in over-all charge of electric engineering work in connection with the Volga hydro-electric projects, said that the size of the turbines to be installed could be judged from the fact that their operating wheels would have a 30 ft diameter, and that rotors would weigh 800 tons; 40 railway trucks would be required to carry all the components to the installation sites. "Only socialist industry and its highly-developed technology are capable of undertaking such tasks."

Says Comrad Arkangelsky. Why, then, during the war, when Russian engineers came over here in droves, did they spend so much time in our plants frantically taking notes and carrying away with them every piece of technical and engineering information they could lay their hands on? Why do their

latest automobiles resemble our Detroit products almost to the last screw hole?—Ed.

The USSR Minister of Engineering, Kazakov, wrote in *Pravda* on 11th October 1950:

"In the field of power engineering the 1946/50 Five-Year-Plan adopted the principle of constructing machines driven by high-pressure and high-temperature steam. The construction of such machines requires less metal and less production hours per unit of power. They are also much more economical in fuel consumption. These turbines (for the Volga projects) will be the most powerful and biggest in the world. Soviet hydro-turbine construction, born in the era of Stalin's Five-Year-Plans, emerged victoriously in competition with capitalist firms. Our Soviet radial-axis turbines installed in the Dnieper power station have proved considerably better—both in design and operation—than the turbines installed in the same station by one of the biggest U.S. firms."

Naturally, capitalist turbines are not very good. Latest figures on American built hydroelectric generators show full load efficiencies of large units of 97.4 per cent, and for 2-pole steam turbine driven generators, 98 per cent. Well, what more do the Russians want?—Ed.

"The research laboratories will have to design a new type of vane with a very high co-efficient of efficiency and good hydraulic qualities. The vanes of the hydro-turbines for the Volga stations must possess such hydraulic qualities as to make it possible to minimize the depth of the power stations:—a decrease in the required depth of only one meter would save the state tens of millions of Roubles."

The intention seems to be to make the two projected power stations—at Kuibyshev and Stalingrad—the principal bases of a centrally-controlled high-voltage grid covering the whole of European Russia. According to official Soviet sources the total output of electric power in the USSR by the end of 1950 was 82,000,000,000 kwhr (the total capacity of all the stations being 22,400,000 kw); the Volga projects will increase this output by another 20,000,000 kw.

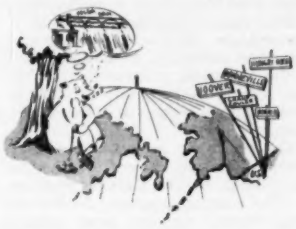
These figures compare with a total generating capacity in the United States of 90 million kilowatts, installed—over four times the entire Soviet capacity. The annual output of the U. S. plants is 383 billion kilowatt hours compared with the Russian 82 billion.—Ed.

Furthermore it is claimed that the Volga basin holds a potential generating capacity of 60,000,000 kw. This, it is said, means that the USSR has greater hydroelectric resources than any other country in the world. When completed, the Kuibyshev and Stalingrad power plants will have a total capacity four times that of all the hydro-electric stations in South America together and about 20 times that of "comparable" plants in Britain.

Why make a comparision with such an undeveloped area as South America or with a country with relatively small hydroelectric capabilities as Great Britain?—Ed.

Kuibyshev and Stalingrad between them would exceed the capacity of 30 (unspecified) large power stations in the U.S. Their output would be nearly twice that of the Grand Coulee and Boulder (Hoover) dams.

In publishing these plans for harnessing the Volga waters, Soviet propaganda, both inside and outside the USSR, has gone all out to detract from U.S. efforts made in this field. Thus it was recently asserted in a broadcast from Moscow Radio that the area of land which would eventually be irrigated by the Volga projects was three times bigger than



the total area which had been reclaimed in the U.S. during the past 100 years. Besides, it had taken the U.S. twenty years to build the Grand Coulee and Hoover dams—which were yet unfinished—while the Volga power stations would be completed within six years.

Tsk, tsk, what brilliant reasoning. Comparing a project that, so far, exists only in the minds of Russians with developments such as in our Colorado and Columbia basin and in the Tennessee Valley, all of which have already been developed to a high degree. It is less than 20 years since Grand Coulee was even started (1935) and it has been in operation for ten years, even now.

The Hoover Dam, according to Soviet propaganda, had been planned to have an annual output of 1,320,000 kw of which only 1,000,000 kw had been achieved so far; for the Grand Coulee dam the figures given by the Soviets were 1,944,000 kw (output planned) and 972,000 kw (output achieved).

These figures are a little bit garbled. We give them as they came to us but the writer evidently meant, installed capacity, not annual kwh output. Hoover Dam has a present installed capacity of 1,034,000 kw and an ultimate capacity of 1,332,000 kw. Grand Coulee at present has an installed generating capacity of 1,650,000 kw and an ultimate capacity of 1,974,000 kw. And that, comrades, ain't peanuts.—Ed.

"The record of the capitalists all over the world in the building of hydro-electric stations is one of buccaneering and crime — Suez, Panama and Assuan all being examples of this."

For weeks past, Soviet propaganda has been busy to contrast "the spirit of peaceful construction" expressed by the Volga projects and the "war psychosis" in the capitalist world.

Since the two Government decrees were published some of the biggest Soviet heavy engineering works have announced that orders for equipment had been placed with them, in some cases requiring the expansion of plant facilities. The factories concerned are:

The Moscow Transformer Works; the Leningrad "Elektro-Apparat" Works (for measuring equipment and switchboards); the Kirov Electric Engineering Works in Leningrad, the "Stalin" Iron & Steel Works (for turbines) in Leningrad; the "Krasny Oktyabr" Iron Works (for turbine) in Stalingrad; the Ksuty Transformer Works in Moscow, the Russky Diesel Works in Leningrad; the Volga Works (for electric motors) in Tallinn; the Gornyak Works (for turbine pumps) at Kutais; Tashkent Cable Works and Kataisk Pump & Compressor Works at Kurghan (both in Asiatic Russia).

Latest reports say construction work on the Kuibyshev site began on 15th October 1950. Eventually this work would involve the excavation of 150,000,000 cubic meters of soil and some 6,000,000 cubic meters of concrete work.

And, one more little fact, comrades, about U. S. power production. During the week which ended December 23, 1950, the central station industry hung up a modest little record of over 7 billion kilowatt hours. In one week, the production was 7,032,740,000 kwhr.—Ed.

MORE POWER FOR GREECE

GREATER UTILIZATION of the potential hydroelectric power and lignite fuel resources of Greece, with the help of ECA, is being planned. The government of Greece proposes to use an $80,000,000 ECA loan to build hydro plants at Agra near Salonika, at Louros in western Greece, and at Ladhon in southern Greece, totaling 95,000 kw.

At Aliveri, about 100 miles outside Athens, an 80,000-kw steam power plant, burning lignite, will be built according to George Weller in the Chicago *Daily News*. These will be connected into a public power grid, which American engineers recommend should be combined with the Athens Light & Power Co.

The Greeks have engaged Electric Bond and Share Co. to build the new enterprises.

At Verria and Ptolemais in northern Greece, a group of wealthy Greek-Americans, says Weller, with an $11,000,000 ECA loan and $4,000,000 of their own, are planning to develop a deposit of 2,000,000 tons of lignite.

Control for a Package Boiler

By **HOWARD T. BAILEY**

Supervisor Electrical Maintenance, Brillion Iron Works

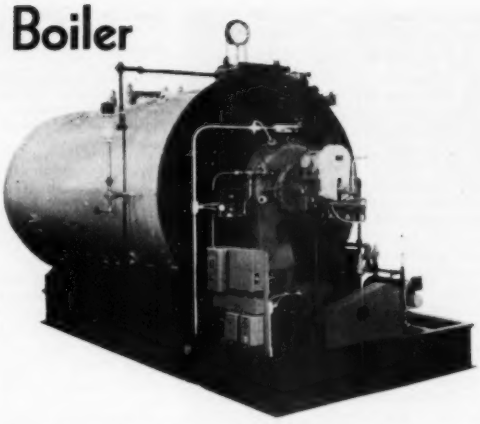


Fig. 1. View of a typical package steam generating unit, with all its automatic controls, assembled and shipped from factory as a unit, ready for connecting to supplies of electricity, feedwater, fuel and to stack for discharge of flue gas. This type operates with forced draft only

COMPLETE, self-contained boilers with full automatic control of all operations, assembled at the factory, installed as a unit, have aroused wide interest throughout industry during recent years. Here are the details of the control and its operation for one of these boilers, of the type shown in Fig. 1.

This particular make is a four-pass horizontal fire-tube steam generating unit, built in sizes from 150 to 500 bhp and for pressures up to 300 psi and sometimes higher. It can be fired with oil or gas or combination oil and gas. The burner is a motor-driven rotary-cup burner, operating on the high-low-off principle, with automatic gas-electric ignition. Primary air is supplied by a blower integral with the burner, secondary air is supplied by a separate blower. Feedwater is supplied at suitable pressure from an outside source, blowdown connections must be provided, steam piping delivers the steam to the consuming equipment, fuel oil (or gas) and electricity are connected, and a stack must be provided to discharge the flue gas. To obtain the high efficiency for which these boilers are designed, knowledge of the various controls and equipment that make up the units is of the utmost importance.

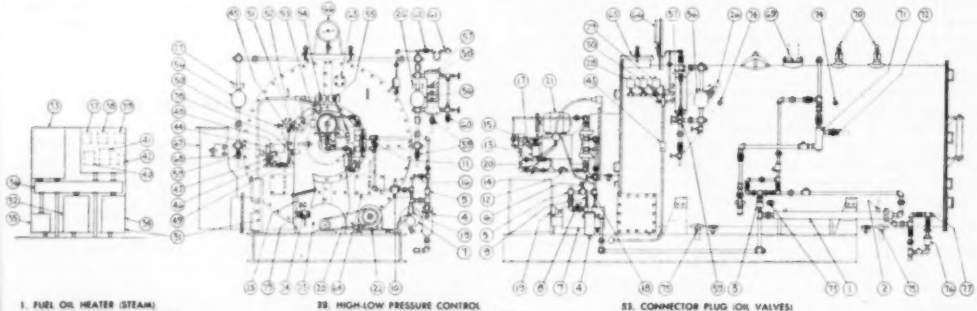
The flame failure control is a combination photo-electric cell and flame rod assembly, an integral part of the electronic programming relay that controls the various starting and stopping operations of the burner.

The electronic programming relay controls the unit under the following conditions: 1—The starting position; 2—The running position; 3—Normal shut down; 4—Line limit control shut down; 5—Flame failure; 6—Safety lockout; 7—Component failure.

Figure 4, A, B, C and D, shows the contact positions in the various phases of operation.

Figure 3 is the schematic electrical diagram of the control system of this electronic control system. All modern safeguards are incorporated in these boilers and with a reasonable amount of preventive maintenance on the various components, little trouble should be expected in their operation. Requirements of such a preventive maintenance program are outlined at end of article. Now let us summarize the operations of the controls shown in Figs. 2 and 3.

As indicated on Fig. 2, the blower motor starter (33) controls the sec-



1. FUEL OIL HEATER (STEAM)
2. FUEL OIL SUPPLY CONNECTION
3. FUEL OIL TEMPERATURE REGULATOR
4. FUEL OIL STRAINER
5. FUEL OIL RELIEF VALVE
6. FUEL OIL RECIRCULATING VALVE
7. FUEL OIL HEATER (ELECTRIC)
8. FUEL OIL PUMP PRESSURE GAUGE
9. FUEL OIL THERMOMETER
10. FUEL OIL PRESSURE REGULATOR
11. BURNER FUEL OIL PRESSURE GAUGE
12. HIGH FIRE KEY VALVE
13. HIGH-LOW OIL VALVE (MOTORIZED)
14. LOW FIRE KEY VALVE
15. THREE-WAY OIL VALVE (SOLENOID)
16. FUEL OIL BY-PASS VALVE
17. BURNER SHAFT OIL SEAL
18. FUEL OIL RETURN CONNECTION
19. ELECTRIC OIL HEATER THERMOSTAT
20. BURNER THERMOSTAT
21. BURNER (SPINNER) MOTOR
22. BLOWER MOTOR
23. SECONDARY AIR BLOWER
24. DAMPER CONTROL MOTOR
25. DAMPER MOTOR POSITIONING SWITCH
26. LOW-WATER CUT-OFF AND FEED WATER PUMP CONTROL
27. AUXILIARY LOW-WATER CUT-OFF
28. HIGH-LOW PRESSURE CONTROL
29. OPERATING LIMIT PRESSURE CONTROL
30. LINE LIMIT PRESSURE CONTROL
31. CONTROL PANEL
32. BURNER (SPINNER) MOTOR STARTER
33. BLOWER MOTOR STARTER
34. ELECTRIC FUEL OIL HEATER STARTER
35. PROGRAM RELAY
36. JUNCTION BOX
37. IGNITION TIMER
38. SAFE START TIMER
39. SCAVENGER TIMER
40. FUSE BLOCK
41. INTERLOCK RELAY
42. "ON-OFF" BURNER TOGGLE SWITCH
43. FEED WATER PUMP MANUAL CONTROL SWITCH
44. IGNITION TRANSFORMER
45. IGNITION CABLE
46. PILOT GAS SUPPLY CONNECTION
47. GAS PRESSURE GAUGE
48. GAS PILOT VALVE (SOLENOID)
49. GAS ADJUSTING NEEDLE VALVE
50. PILOT AIR VALVE
51. GAS PILOT ASSEMBLY
52. FLAME ROD CONNECTION
53. PHOTOCELL ASSEMBLY
54. CONNECTOR PLUG (BURNER MOTOR)
55. CONNECTOR PLUG (OIL VALVES)
56. FLOAT BOWL
57. WATER COLUMN
58. TRY-COCKS
59. WATER COLUMN BLOW-DOWN VALVES
60. GAUGE GLASS BLOW-DOWN VALVE
61. VACUUM BREAKER
62. VACUUM BREAKER SHUT-OFF VALVE
63. INSPECTION PLATE
64. CLEANOUT DOOR
65. RELIEF DOOR
66. STEAM GAUGE
67. VENT
68. VENT SIGHT DOOR
69. STEAM CONNECTION
70. POP VALVES
71. INJECTOR (OMIT ON 15# D.P.)
72. INJECTOR WATER SUPPLY CONNECTION
73. FEED WATER CONNECTION (R. & L.)
74. SURFACE BLOW-OFF CONNECTION
75. BOTTOM BLOW-DOWN CONNECTION
76. STEAM TRAP
77. FUEL OIL HEATER CONDENSATE DISCHARGE CONNECTION
78. BURNER SIGHT HOLE
79. DAMPER CONTROL MOTOR AUXILIARY SWITCH

Fig. 2. Schematic diagram showing location of pre-assembled piping and controls on steam generating unit of Fig. 1 (Courtesy Cleaver-Brooks Co.)

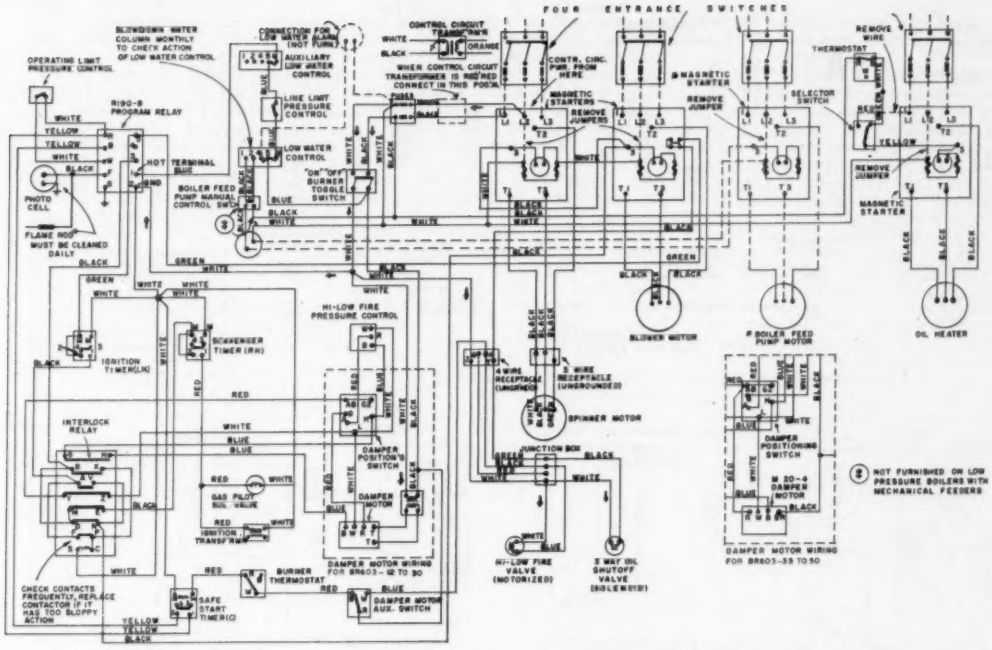


Fig. 3. Wiring diagram of controls on package steam generating unit of Fig. 1 (Courtesy Cleaver-Brooks Co.)

ondary air blower (23); the burner motor starter (32) controls the spinner or oil-burner motor (21).

The boiler is equipped with a low water control (26) which is a combination low-water cut-off and pump switch. These switches are float operated, and their position is determined by the water level in the boiler. The pump switch starts and stops the boiler feed pump as necessary to maintain the correct water level. The low-water cut-off switch breaks current to the control circuit and shuts down the burner if for any reason the boiler water drops below a safe operating level. As an added safety measure an auxiliary low-water cut-off switch is provided in most cases (27).

A very important control is the "high-low" steam pressure control (28). This control causes the burner to operate at high or low fire, as required to maintain proper operating pressure and is a steam-pressure-actuated, three-wire, two-circuit mercury-tube switch.

As an example when the steam pressure falls below a pre-determined point, the pressure switch (28) will close, causing the damper-control motor (23) to turn the damper on the main blower to its full open position. When steam pressure reaches the desired value, as set on the high-low three-wire pressure control, the high-fire circuit will be opened and the low-fire circuit closed. This will again operate the damper control motor, but to CLOSE the blower damper to a throttled position.

At the same time, the auxiliary switch will rotate to open the circuit to the motorized valve (13) causing it to close. Low-fire burner operation now goes into effect, with three-way solenoid valve (15) still open. Adjustment of the key valves permits regulation of the oil flow at high-low fire, respectively, to adjust the correct amount that can be properly burned with the amount of air that the large blower is supplying.

A two-wire pressure control known as the operating-limit pressure control (29) provides burner shut-down when the maximum desired steam pressure is reached. This is accomplished by breaking the holding circuit of the program relay (35), which results in burner shut-down, but leaves the electronic circuit of the program relay energized.

Another two-wire pressure control, designated as the "line-limit pressure control" (30), is connected electrically in series with the low-water cut-off switches. When this control opens its contacts, the hot line to the program relay and the burner-control circuit is broken. The line-limit pressure control is usually set at about 5 psi higher than the operating limit pressure control.

A burner thermostat interlock switch (20) is used to prevent starting of the burner when the oil temperature is below the setting of the thermostat.

The heart of the automatic control system is the electronic relay (35). All safety controls act upon this relay to start or stop the burner as conditions warrant. Instantaneous burner shut-down in event of flame failure is provided by the relay in conjunction with a photocell (53), which monitors the flame.

Sequence of Operation

Referring to Figs. 3 and 4, control circuit power is taken from terminals L1 and L3 in the spinner starter and is fed through fuses to a double-pole toggle switch. L1 supplies the "ground" or common line; then L3 supplies the "Hot" line.

From the toggle switch, ground line current is supplied as follows:

1. To the magnet coil circuits of the spinner and blower starters. Note that the overload breakers of these starters are connected in series, so that an overload release of the spinner starter will also shut down the blower starter.
2. To one side of both oil valves.
3. To one side of damper motor power circuit.
4. To terminal 2 (the ground terminal) in the program relay.

Hot line current flows from the toggle switch as follows:

1. To the damper motor power circuit.
2. To the damper motor auxiliary switch.
3. To the low water control, line limit control, and auxiliary low water control to terminal 1 (the hot terminal) in the program relay.

With power on the program relay terminals 1 and 2, Fig. 4, relay's electronic circuit is energized and vacuum tube heats up. The tube remains non-conductive, however, until later in the sequence when pilot flame is established and contacts flame rod.

With the damper motor powered, its position is normally determined by the setting of the damper positioning switch when the switch is set to "high or low" position. With the positioning switch set to "auto-

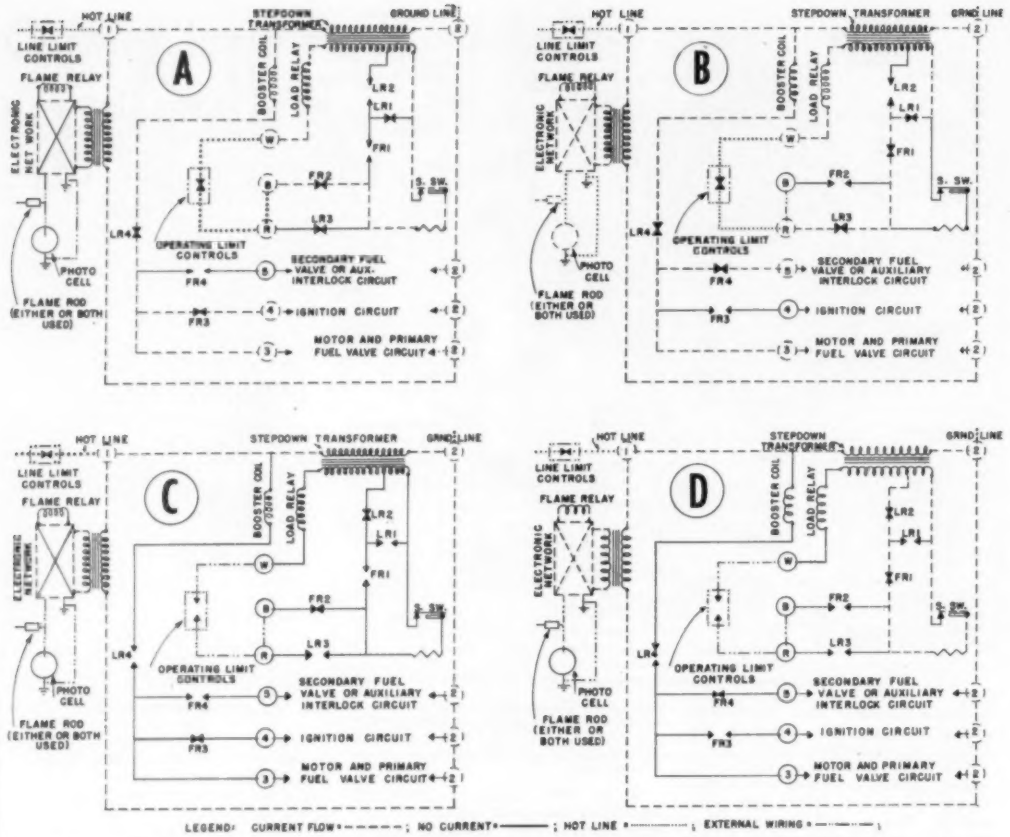


Fig. 4. Various phases of operation of electronic programming relay in controlling the unit showing contact positions. Dotted lines indicate current flow. (Courtesy Cleaver-Brooks Co.)

A—Position of contacts in starting; load relay has pulled in, current is supplied to motor, fuel valve and ignition circuits. B—Running position after flame has been established and flame detector has sensed presence of flame. When this occurs, ignition circuits are de-energized in turn de-energizing fuel valve or auxiliary interlock circuit. C—Position of contacts during normal shut-down. D—If flame fails, flame detector circuit will be de-activated, dropping out the flame relay immediately and going into safety lockout at end of timing period. Safety lockout is indicated in C and component failure in D. This program control is connected to the circuits as shown in Fig. 3 and details of operations are given in the text.

matic" the motor position is normally controlled by the high-low pressure control.

During the starting sequence, it is desired that the damper motor turn to low fire position and remain there until flame is established. To accomplish this, interlock relay contacts Y-Z (normally closed) and G-H (normally open) are connected in such a way that the low fire circuit is closed and the high fire circuit is open, allowing the motor to run to low-fire position and preventing it from turning to high-fire position.

With oil temperature at normal, current now flows through auxiliary-switch low-fire contacts and through the burner thermostat to the safe-start timer pull-in coil, the other side of which connects to electronic relay terminal 2. At the completion of the timer's delay period, its load contacts will close, shorting electronic relay terminals R and B.

Electronic relay terminals R and W are shorted by the operating-limit pressure control, whose contacts are closed whenever pressure in the boiler is less than pressure at which the control is set to cut out. With electronic relay terminals R, W, and B thus shorted together, and with terminals 1 and 2 energized, the electronic relay terminal No. 1 (left hand) relay jack will pull in, closing internal contacts between terminals 1 and 3. Hot line current then flows from relays terminal 3 to interlock relay terminals B, D and M through the interlock contacts D-N to the terminals in the blower and spinner starters, pulling the starters in and starting the motors. Simultaneously the scavenger timer is energized through interlock contacts M-E.

At the completion of the scavenger delay period, the timer's load contacts will close, energizing the ignition transformer and opening the gas pilot solenoid valve. With gas, air (from blower), and ignition spark provided, the pilot will light.

Contact of the flame rod by the pilot flame will trigger the relay's electronic circuit, causing its vacuum tube to conduct and its No. 2 (right-hand) relay to pull in. Pull in of the electronic relay closes the contact between terminals 3 and 5. Hot line current is now supplied from terminal 5 through the left-hand interlock contacts in the blower starter to the three-way solenoid oil valve, and the valve opens. Current is also supplied from terminal 5 to the pull-in coil of the ignition timer. The timer should be adjusted to provide a delay of 15 sec. This is the period during which the oil is given a chance to ignite.

Flame Established

Assuming that oil, air, and pilot flame are present in correct amounts, the flame will be established, and the photocell will be activated by light from the flame. For the balance of the ignition period, the pilot remains lighted, and the electronic

relay's circuit is proved by both the flame rod and photocell, whose functions overlap at this time.

When the timer's ignition period is completed, the timer's load contacts close and power is fed from relay terminal 5 through the load contacts to interlock relay terminals A and F. Current then flows through contacts F-T to the interlock relay holding coil, causing the relay to pull in. The interlock relay contacts are of the make-before-break type (a worthwhile point to remember when trouble-shooting) and pull-in of the relay transfers or transposes power sources as follows:

1. The interlock relay, initially powered by electronic relay terminal 5 via ignition timer and interlock contacts F-P, is held in by power from electronic relay terminal 3 via interlock contacts B-X.
2. The blower and spinner motor starters, initially powered by electronic relay terminal 3 via interlock relay contacts D-N, are held in by power from electronic relay terminal 5 via interlock contacts A-V.

Pull in of the interlock relay also accomplishes the following:

1. Scavenger timer, gas pilot solenoid valve, and ignition transformer are de-energized by the opening of interlock contacts M-E.
2. Damper motor is restored to control of the damper positioning switch and the high-low fire pressure control, by the closing of interlock contacts G-H and the opening of interlock contacts Y-Z.

With the pull-in of the interlock relay, the starting sequence is completed. The pilot flame having been extinguished, the flame rod no longer has any effect on the electronic relay and continued operation depends upon the monitoring function of the photocell. If the photocell viewing lens becomes dirty, or the flame fails, or the photocell becomes defective, the relay's electronic circuit will cease to conduct, and the number 2 relay jack will drop out, de-energizing terminal 5. The system is now in flame failure condition, and the following events occur:

1. The three-way oil shut-off valve, which was powered from electronic relay terminal 5, closes, shutting off oil to burner and bypassing it to the tank return line.
2. The interlock relay, which is powered, after pull-in, by electronic relay terminal 3, continues to hold in and thus prevents return of ignition.
3. The blower and spinner starters, which are powered by electronic relay terminal 5 after the starting sequence is completed, are de-energized immediately when the electronic relay No. 2 relay jack drops out.
4. Electronic relay No. 1 relay continues to hold in and terminal 3 remains hot until the safety switch (in the electronic relay) opens its contacts after approximately 45 sec.

With drop-out of No. 1 relay, terminal 3 is de-energized allowing the interlock to drop out. The system is now in safety shut down position, and the burner can only be restarted by manually resetting the electronic-relay safety switch. Unless the condition which caused safety shut down is corrected, the unit will fail to re-light or will operate only until the starting sequence is completed, when it will again shut down and go into safety lockout.

Assuming that the burner and control system functions properly, the burner will, upon completion of the starting sequence, turn from low fire to high fire or from high fire to low fire, as dictated by the high-low pressure control, provided the damper positioning switch is set to the automatic position. As mentioned previously, the burner should be kept in low fire position (damper-positioning switch set to "low") when starting a cold boiler, and should not be allowed to operate in the "automatic" position until at least a third of the operating steam pressure is reached.

If the boiler develops steam in excess of demand until the limit pressure is reached, the operating-limit pressure control will open its contacts. This breaks the electronic relay holding circuit, and the No. 1 relay will drop out, de-energizing terminals 3 and 5, and shutting down the burner. All controls assume their starting position, and the burner will re-light when the pressure drops sufficiently to allow the operating-limit control contacts to close, and provided all other conditions necessary for starting are met.

If low water control or line limit control opens its contacts, the hot line to electronic relay terminal 1 is broken and the burner will shut down. As soon as all contacts in this line are restored to closed position (water level corrected and low-water control reset, or pressure dropped below cut-out point of line-limit pressure control) and all other controls being in proper starting position, the burner will re-light.

Preventive Maintenance Is Vital

Importance of preventive maintenance cannot be over-emphasized. It acquires its proper significance when examined from the point of view of equipment utility. Equipment must be kept running efficiently if it is to serve its purpose. Equipment not properly maintained will rapidly become useless.

Preventive maintenance prolongs the life of the boiler and contributes to the success of the process operations for which the equipment is employed. However, by its very nature, preventive maintenance requires the whole-hearted interest of the personnel assigned to it. Persons charged with this responsibility should have a keen appreciation why the work is required and how important even the most routine tasks are to the over-all performance of the unit.

To maintain the designed performance of these units, the following schedule of maintenance should be strictly followed:

Daily Operation:
1. Clean flame eye and flame-rod assembly by brushing off soot accumulation from the flame rod; clean flame eye-glass.
2. Clean burner, removing excess carbon and sludge.
3. Blow down boiler.
4. Keep oil regulator adjusted for clean flame.

Monthly:
1. Check all contactors for badly burned or pitted contacts.
2. Remove flame electrode assembly, dismantle and clean thoroughly.
3. Clean oil-line filters.

Yearly:
1. Open boiler, wash down, check tubes and make any necessary repairs.
2. Remove all strainers or filters and clean thoroughly. This is a frequent source of trouble.

The above procedure should by no means be the extent of preventive maintenance. For truly efficient operation, the person in charge must never be content with just keeping up steam but should go a step farther by keeping a constant check on the operation of the boiler.

THE GOOD MAINTENANCE MAN IS NEVER SATISFIED WITH SOMETHING GOOD BUT IS FOREVER STRIVING FOR THE BEST.

NEW ALUMINUM PLANTS TO REQUIRE BIG BLOCKS OF POWER

PLANS HAVE recently been announced for new aluminum plants scheduled to go into operation by the end of this year. One is a new plant for Kaiser Aluminum and Chemical Corp. to be built in New Orleans for a capacity output of 200,000,000 lb a year. The other is a plant for Reynolds Metals Co. for a capacity of 150,000,000 lb of aluminum pig a year, to be erected on the shore of Corpus Christi Bay near Gregory, Texas.

The Kaiser plant, it is reported, will probably install some 80 internal combustion engines burning gas to produce 1300 kw d-c power each and, in addition, a 120,000 kw steam plant. Some of the output of this steam plant will be converted to d-c for aluminum potline use.

The Reynolds plant is expected to install Diesel engines burning natural gas with a total capacity of about 175,000 kw.

Both projects include development of new bauxite deposits in Jamaica.

Aluminum Co. of America plans to build a new aluminum plant near Bauxite, Ark. Construction is to begin immediately. It will be designed to process low-grade bauxite ore and increase the company's output of alumina by nearly 50 per cent. The new plant will be located on a 200-acre site adjoining the bauxite mining operations of Alcoa Mining Co.

Low-grade bauxite will be the raw material for the proposed plant, its use being based on a combination lime soda-Bayer process developed for that purpose during World War II. Entire construction project, including new housing for 1000 additional workers, will be carried out entirely by Alcoa, serving as its own general contractor.

New Diesel Plant Serves N-E Missouri Co-ops

Northeast Missouri Electric Power Co-operative puts three 3500-hp Fairbanks-Morse Diesel Generating units in service to supply six REA Member Co-ops. Plant is a Dual power plant, a 15,000-kw high-pressure steam turbine plant being under construction. The steam plant will carry the base load

By M. W. BOUDREAUX General Manager, Northeast Missouri Electric Power Co-ops

THE NORTHEAST MISSOURI Electric Power Cooperative, one of the nation's newest and largest rural power co-ops, has put into service a new 10,500-hp diesel plant embodying three of the largest Fairbanks-Morse diesels ever built. This unique power plant is the first generating unit in a great system which ultimately will serve 55,000 farm homes in 27 counties of northeast Missouri and south central Iowa.

This broad area has not had in recent years a power supply adequate to meet the growing demand. Rural electrification cooperatives secured much of their power from municipal plants but the short supply seriously restricted load development. To meet this situation six distribution co-ops formed in 1948 a non-profit power cooperative designed to meet all their generating requirements. The power co-op would build, own and operate such generating systems as proved necessary, a 69,000-v transmission system from the plants to the member co-ops' load centers, and the substations at these centers to step voltage down to 7200.

First power fed into the distribution system came from the Bureau of Mines' coal-to-oil demonstration plant at Louisiana, Mo., which has generating capacity far exceeding its current requirements. Next, the power co-op proceeded with all possible speed to design and build its own major generating station on the west bank of the Mississippi about seven miles northeast of Palmyra, Mo. This site provided uncommonly good accessibility for the transportation of fuels. Docking facilities under construction will permit fuel delivery by barge. A spur was built to tie the plant to a main rail line. A transmission line of a major natural gas pipeline company actually crosses the co-op's property.

South River Station is a dual power plant: first, a 10,500-hp diesel plant, second a 15,000 kw high-pressure steam turbine plant. When completed the steam plant will carry base load with the diesel plant taking the peaks and providing standby protection. Actually the diesels may be destined for 24-hr operation. The first engine was put on the line for test purposes July 29, 1950. The three-engine plant was officially energized on October 20, 1950. Last month (April, 1951) the diesel plant went on the line 24 hr a day as base load generators pending completion of the steam plant. But rural load is growing faster than anyone believed possible and it is conceivable that the demand will require continuous operation of the diesel plant for years to come.

In designing the three-engine plant the Stanley Engineering Co., consulting engineers, kept two objectives in view: a plant that could be put on the line quickly to carry surging peaks or compensate for the failure of other power supply; a plant that could produce kilowatt hours dependably and at low cost in long arduous service. Diesels of course are ideal standby units since they can be started quickly. In this plant equipment and controls are arranged so that the engines can be put on the line in less than a minute from a cold start with no input of power to the plant. Starting air bottles are kept up to 250 psi by an automatically controlled motor-driven compressor but a gasoline engine can be used to run the compressor if no power is available. The switchboard is in a partitioned, glassed-in control room overlooking the engine room and holds all the switches, meters and other instruments necessary to control the engines and the electrical system.

The engines chosen are 3500-hp, 10-cylinder, 18 by 27-in., Model 31AD 18 Fairbanks-Morse dual-fuel units which develop their rated

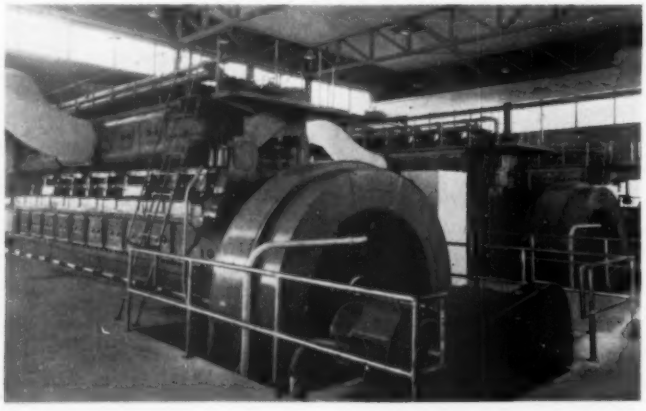


Fig. 1. General view in the engine room of the South River Station. Three 3500-hp engines drive 2480-kw 3-phase, 4160-v generators

horsepower at 277 rpm. Each 2-cycle engine drives a 2480-kw, 3-phase, 60-cycle, 4160-v Fairbanks-Morse alternator with a 30-kw chain driven exciter.

The plant is designed for virtually automatic handling of lubricating oil. There is an 800-gal clean oil tank in the basement for upper cylinder lube with a motor-driven pump to transfer lube through a meter for each engine to individual 100-gal supply tanks. From these tanks the oil is pumped to two mechanical lubricators for each engine. There is a return line to the supply tank to maintain oil level in the lubricators. These are wet sump engines requiring approximately 1000 gal for the original fill. Bearing lubricant is drawn from the crankcase by a motor-driven positive displacement pump which discharges through an oil cooler and strainer to the bearings. The lube flows up through the connecting rods to cool the pistons and returns to the sump by telescopic lines. There is a cellulose-type filter for each engine. When the engine is in operation some lube is by-passed through the filter from the pressure system. When the engine is not running, a motor-driven pump draws oil from the crankcase and puts it through the filter. The plant has an 1800-gal dirty oil tank so that lube can be drained for batch purification if necessary. There is an auxiliary lube pump driven by either a motor or a gasoline engine. Pressure in the lube header is maintained at 30 lb and temperature is kept between 155 and 165 F, by a modulating valve regulating the flow of water through the oil cooler.

Initially, the cylinder lube handling will not follow the described pattern because the operating staff wants to try a different lubricating oil in each engine. When a reasonably long use test demonstrates the superiority of any one oil, the entire plant will be switched to that lubricant and the automatic features of the lube handling system will be utilized.

The engines are designed as dual-fuel units to burn natural gas with a small quantity of pilot oil but are currently being operated as oil-burning diesels pending the completion of the gas line that will bring natural gas to the plant. Fuel oil is unloaded by a 100 gpm motor-driven rotary pump into three 50,000-gal vertical cylindrical tanks 700 ft from the plant, first passing through an air eliminator and a meter. From storage, the fuel flows by gravity to the suction of two motor-driven transfer pumps which put the oil through a heat exchanger and a pair of cellulose filters into a 17-lb header. From the header there are lines through separate meters to 150-gal day tanks for each engine. The transfer pumps run continuously and float-controlled valves admit oil to the day tanks as necessary. Fuel is picked up from the day tank by the engine's own supply pump and fed through a header to the injection pump at each cylinder.

For dual-fuel operation, there will be separate fuel pumps to meter accurately the small charges of pilot oil. As a dual-fuel, the engine can be switched instantly from oil to gas or from gas to oil. The switch will be automatic in case gas pressure fails. The governor is arranged so that half its travel controls gas admission, the other half fuel oil for full diesel operation.

From our operations thus far, we are satisfied with engine efficiency. We are using a 33.6 API fuel oil for which the delivered price is 10 cents a gallon. We estimate that on dual-fuel operation, our total fuel cost will be under 4 mills per kwhr.

The Mississippi will be an important water source for the steam plant, but wells provide a more convenient supply of clean water to cool the diesels. Three motor-driven well pumps supply 425 gpm each to the raw water header from which water flows through modulating valves to the oil coolers and heat exchangers and then to waste. The engines are cooled by a closed system with well water circulated by three motor-driven centrifugal pumps through the exchangers and the engines. Some of the jacket water is drawn off to the fuel heat exchanger to warm the fuel and then returns to the engine inlet header. There is a surge tank for each engine and all are tied to a header which serves to keep all the engines warm if one is running. What little make-up water is required is treated in a softener and pumped into the surge tank. There is also one well and a service tank for potable water for building use.

Scavenging air for each engine is drawn through an automatic self-cleaning filter in an air house outside the plant. A 2-in. vacuum is maintained in the crankcase. There are dual exhaust headers, each serving five cylinders. The exhaust lines join and vent through a vertical silencer mounted on the air house.

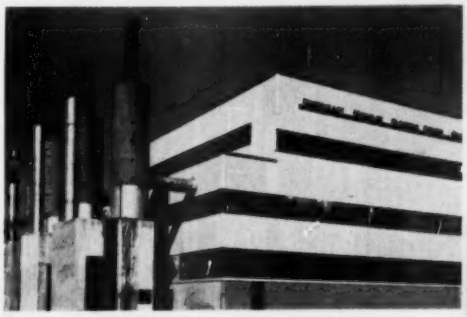


Fig. 2. (Right) View of the exterior of South River Station. Intake air passes through self-cleaning filters in concrete housings. Exhaust gases pass through vertical silencers

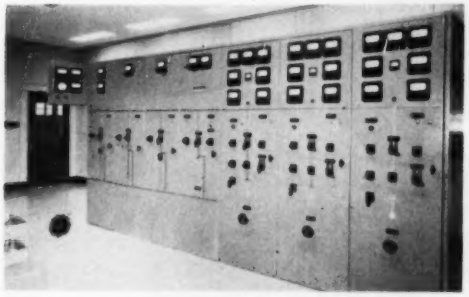


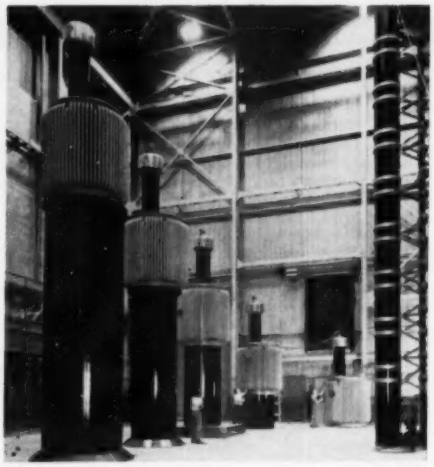
Fig. 3. (Left) The modern switchboard is located in a partitioned, glassed-in control room overlooking the engine room. It holds all controls for both engines and electrical system

Both for operating ease and engine protection, the plant has practically complete instrumentation. The main switchboard includes voltage regulators, governor controls, synchroscope, oil circuit breakers, field switch, temperature indicator, a-c and d-c voltmeters and ammeters, kw meters and time-hour meters which are energized when the field switch is closed. In the engine room there is a panel holding pressure gages on the starting air header, the fuel oil header, cooling water header, and cooling water suction. This panel also has control switches for the two fuel transfer pumps, two lube transfer pumps and three water pumps. There are alarms on low fuel pressure, low air pressure and softener regeneration. Finally the board has level meters on the fuel storage tanks. There is a separate gage panel beside each of the three engines with a multi-point exhaust pyrometer and gages on fuel, lube, starting air, jacket water and gas. Switches control the water pump, lube pump and lube purifier pumps. There are alarms on low lube pressure, high lube temperature, high jacket water temperature, low jacket water pres-

(Continued on page 110)

Power Engineering

Left — Checking up Dr. Albert Einstein! Here is special apparatus used at New York University College of Engineering to measure the effect of speed on the mass of an electron, in order to check Einstein's theory of relativity. Every time an electron is emitted from Radium D in specially-evacuated chamber, a Geiger counter clicks

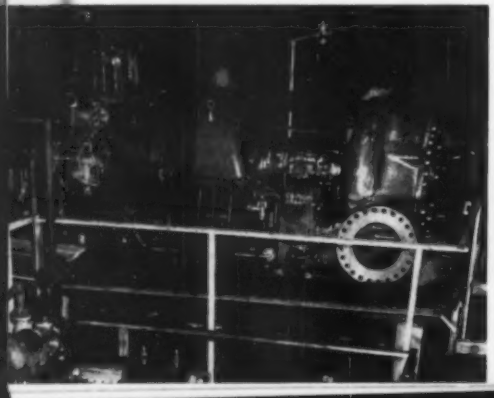


Above—Shocking! they say—for the transformers, connected in series, mounted for testing on insulating towers in GE's high-voltage lab at Pittsfield

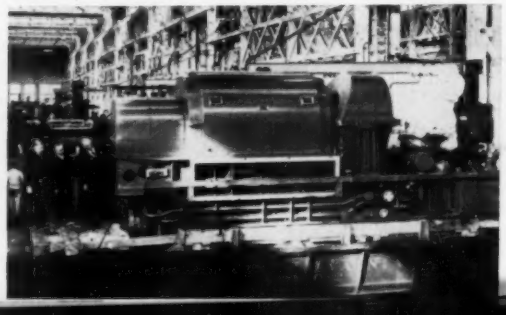
Above—Progress at Salem Harbor. This is how the new station, under construction by New England Power Co. at Salem, Mass., looked on February 28, 1951. First of two 75,000-kw generating units scheduled for operation in fall of 1951. Looks from here as though they'd make it. Steam at 1450 psi, 1000 F, of course.

Right—Operator paints water heater tank with steam spray gun using new method, employing superheated steam instead of compressed air, at Kellogg Div. of American Brake Shoe Co. Superheated steam spray method, invented by du Pont, heats finishing material, allows heavier coats without running, reduces pinholing and popping

Below—Steam power for a gas pipeline—a DeLaval steam turbine-driven centrifugal compressor, one of three, for Transcontinental Gas Pipeline Corp. Station power for compressor stations will be supplied by DeLaval 600-psi, 750-F, 20-psig back pressure, 480-v turbine generators

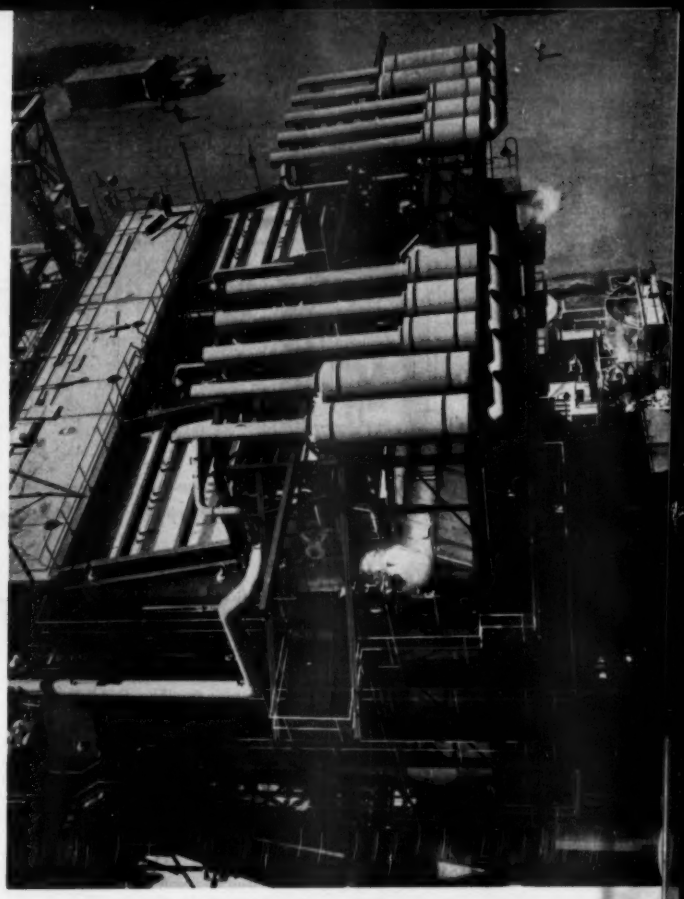


Below—Packaged Westinghouse 5000-kw, 400-psi, 750-F, 3600-rpm generating unit—steam turbine, steam condenser, electric generator—mounted as a single unit, ready for shipment from the Sunnyvale, California plant of Westinghouse, to the City of Thomasville, Georgia



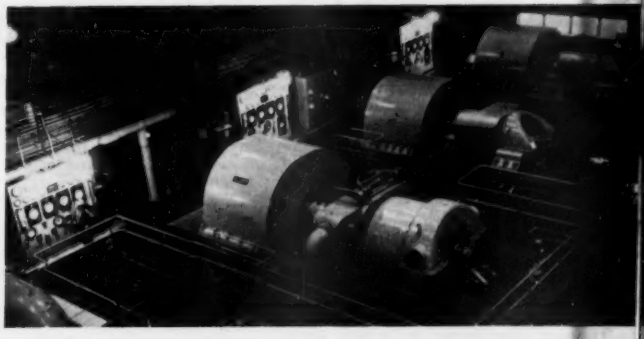
NEWS REEL

Above—Largest centrifugally-cast iron piston ring, one of 36, each 29-in. diameter, produced by Double Seal Ring Co. for use in the Tacubaya, Mexico, 8650-hp Diesels burning heavy oil (See PG, September 1949). Oh, yes!—the young lady is Miss Flo Alexander of Fort Worth, Texas

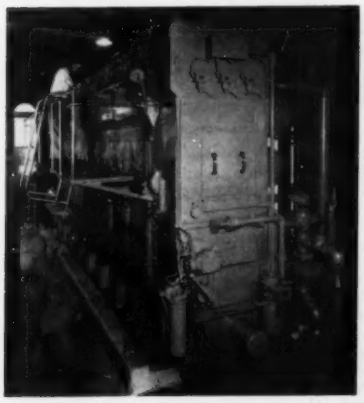


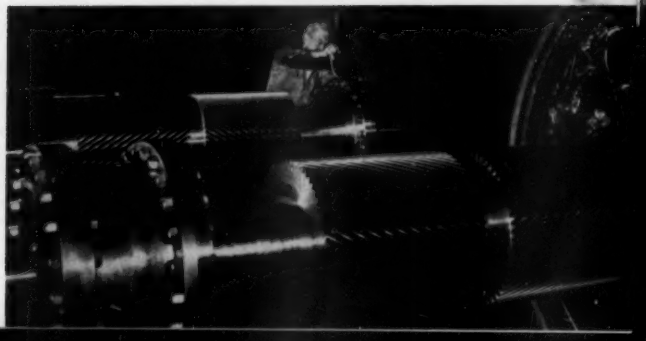
Right—Top view of one of two Foster Wheeler outdoor 220,000-lb-per-hr, 945-psi, 905-F steam generating units at Morgan Creek Steam-Electric Generating Station of Texas Electric Service Co. showing safety valve discharge silencers

Right—New De Laval 121,000-cfm blast-furnace turbo-blower in foreground, driven by 650-psi 750-F steam turbine, installed by Dravo at Edgar Thomson Works, Carnegie-Illinois Steel Corp.



Below—Dual fuel, supercharged 1080-hp, 360-rpm Superior Diesel engine for installation at Arcanum, Ohio, Municipal Plant





Right—Pinions and gears for a GE marine propulsion unit (cross-compound, 12,500-hp, 90-rpm, 850-psi, 890-F, double reduction gear turbine set) being assembled at Lynn for shipment to Ingalls Shipbuilding Co., Pascagoula, Miss.

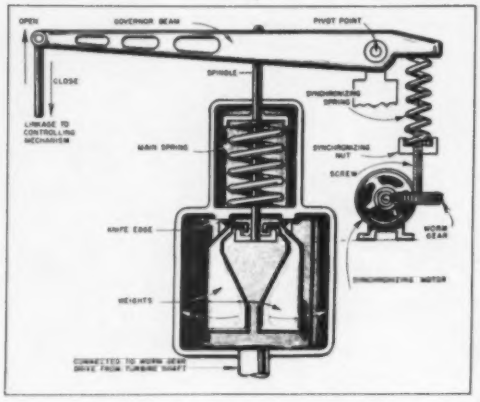


Fig. 1. Simplified diagram of a typical governor on a large turbine generator

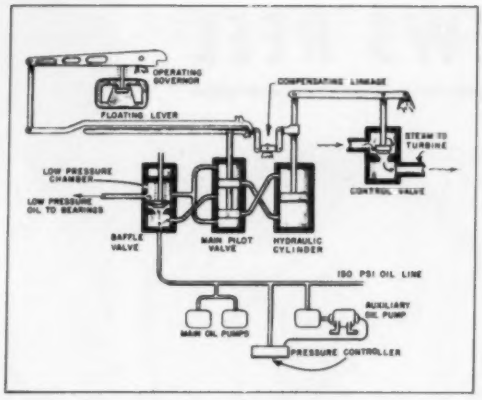


Fig. 2. To the governor of Fig. 1 we add first the main pilot valve and its operating mechanism

A Steam Turbine Governor at Work

By GORDON HOUSER

Junior Engineer The Detroit Edison Company

MAIN JOBS of a governor on a large turbine generator are: 1, to regulate the speed of the machine while it is being synchronized; 2, to control the load on the machine when it is on the line.

Figure 1 shows a simplified diagram of a typical governor. Its basic parts are weights, main spring and spindle. These are contained in a casing, which is revolved by the turbine shaft through a worm gear.

Governor Principles

As the weights revolve, centrifugal force tends to push them outward. This causes them to pivot around the knife edges so that their hooks pull down on the spindle. This motion, however, is opposed by the main spring.

The spindle is connected to the governor beam by a transmission bearing, so that the beam moves up and down with the spindle. The beam, in turn, is connected to the turbine's controlling mechanism, which operates the controlling valves. When the weights move outward, the beam is pulled down, causing the controlling mechanism to close the valves. When the weights move in, the mechanism opens the valves.

When the machine is at rest the weights are in a vertical position. As its speed is increased, centrifugal force moves the weights out against the spring force. When the machine reaches normal speed, say 1800 rpm, the weights are almost to the extreme "out" position. The valves are then open only enough to permit enough steam to enter the turbine to maintain this speed.

Variations in turbine speed above or below normal change the centrifugal force, causing the weights to move out or in against the force of the spring, thus moving the spindle and beam to open or close the turbine valves and admit more or less steam to the turbine, increasing or decreasing its speed until forces of weights and spring again balance.

The synchronizing spring changes the force exerted by the main spring against the weights. Compression of this spring is changed by moving the synchronizing nut up or down by turning the screw. And the screw is turned by the motor which is operated from a toggle switch in the switchboard gallery. In this way the operator can vary the speed of the machine from about 1750 to 1875 rpm.

Putting the Machine on the Line

Before the machine can be put "on the line," its speed must correspond to that of the system frequency.

If the machine's speed is too high, the operator moves the toggle switch to the "lower speed" position. This energizes the motor, turns the screw and raises the synchronizing nut. The synchronizing spring is compressed, partially overcoming the force of the main spring. This allows the weights to move out. As they move out, the valves close. The flow of steam is cut down, lowering the machine's speed until the force of the weights and spring again balance.

Once the machine is on the line, its speed is controlled by the frequency of the system. The governor is then used only to control the load on the machine.

When the machine is on the line, but is carrying no load, the governor weights are in the extreme "out" position and the valves are closed. To pick up load the operator moves the toggle switch to the "raise speed" position. This lowers the synchronizing nut and decreases the compression of the synchronizing spring. The main spring can then overcome the force of the weights. The weights move in, raising the spindle and opening the valves, an amount determined by the amount the synchronizing nut is lowered. The action of the governor while the machine is on the line thus takes care of small changes in load. Large changes are taken care of by operation of the synchronizing nut from the switchboard station.

Now we'll see how the controlling mechanism operates the control valves, according to orders from the governor.

How the Governor Controls Through Its Operating Mechanisms

Oil is used not only for lubricating the turbine bearings but also to supply the force that moves the various parts of the turbine's controlling mechanism.*

This mechanism is made up of two parts, the operating mechanism and the emergency tripping mechanism.

This article is an abstract and rearrangement of a series of 5 articles that appeared during 1950 in *Coal to Kilowatts*, published by the Production Department of The Detroit Edison Co. At that time, John Hamann was editor of *Coal to Kilowatts*; Frank Nitzberg is now editor. Our thanks to them, to the author and to The Detroit Edison Co. for cooperation and for permission to re-publish this material.—The Editors

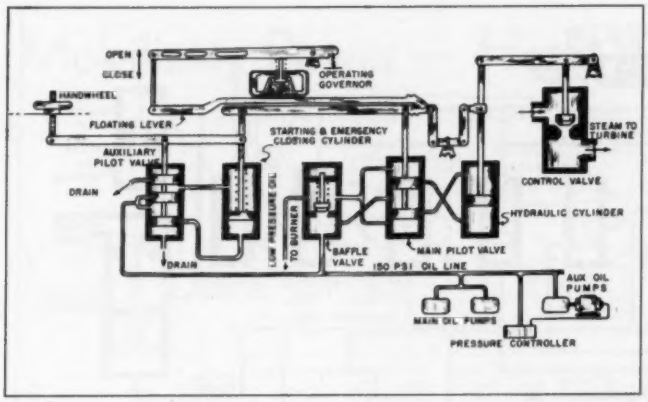


Fig. 3. To the mechanism of Fig. 2 we add next the starting cylinder, its auxiliary pilot and adjusting handwheel

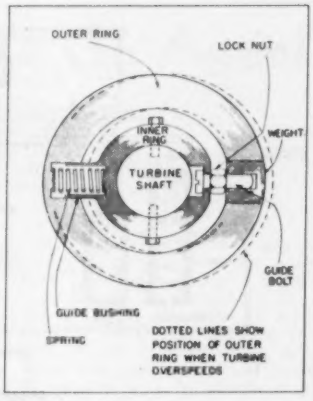


Fig. 4. Next we use an emergency governor of the unbalanced ring type, mounted on the main shaft of the turbine

The operating mechanism's job is to open or close the control valves according to the movement of the operating governor beam.

Here's How it Works on One of Our Big Units

When the machine is running at or near normal speed, oil is supplied by twin gear-type oil pumps, driven by the turbine shaft through worm gears.

In case of failure of the main pumps, oil is supplied by an electrically driven auxiliary pump. A pressure controller automatically starts the auxiliary pump when the oil pressure drops below about 115 psi.

Oil from the pumps is supplied to the operating mechanism through a baffle valve, which keeps the oil pressure at 150 psi. This valve works like a relief valve. It is spring-loaded so that when the oil pressure beneath it reaches 150 psi, the valve opens, keeping the oil pressure from going any higher. This allows oil to flow to the low-pressure system which feeds the bearings. The valve is open at all times when the machine is running.

Main parts of the operating mechanism are: (1) Operating governor; (2) Main pilot valve; and (3) Hydraulic cylinder.

These units are all tied together through a lever system.

The main pilot valve, Fig. 2, is a piston-type valve with two disks attached to its stem. The top and bottom ports are connected to the low pressure chamber of the baffle valve, so that oil can be discharged from the valve cylinder. The center port is connected to the 150 psi oil supply line so that oil can be supplied to the valve cylinder. The two ports leading to the hydraulic cylinder are covered by the disks during periods of constant load.

Near the main pilot valve, where it is mounted inside the No. 1 bearing pedestal, is the hydraulic cylinder. This cylinder has a double-acting piston. The piston rod is connected to the control valve opening mechanism, also to the governor compensating linkage.

How the Parts Work Together

Let's see how these units work together. Assume that the switchboard operator wishes to decrease the load on the machine. He moves the toggle switch which energizes the synchronizating motor and increases the compression of the synchronizing spring.

This allows the weights to move the governor beam down. As the beam moves down, it pushes down on the floating lever. The floating lever, in turn, pushes down on the main pilot valve stem, moving the disks downward. This will uncover the ports leading to the hydraulic cylinder and 150 psi oil will flow through the lower port to the top of the hydraulic cylinder piston. At the same time, the oil below the piston will be discharged to the low pressure system. The pressure on top of the piston forces the piston down. As it moves down, it decreases the opening of the control valves, cutting down the flow of steam to the turbine and reducing the load on the machine.

At the same time, however, the downward movement of the piston rod will, through the compensating linkage, move the floating lever back up. This will cause the pilot valve stem and disks to move up. When the disks reach their original neutral position (covering the ports to the hydraulic cylinder), the flow of oil to and from the hydraulic cylinder will stop. This will stop the movement of the piston.

This restoring or compensating motion is very important. Because of it, for any governor beam position, there is a corresponding definite position of the control valves.

Several control valves are under command of the hydraulic cylinder, and their lifting cams are arranged

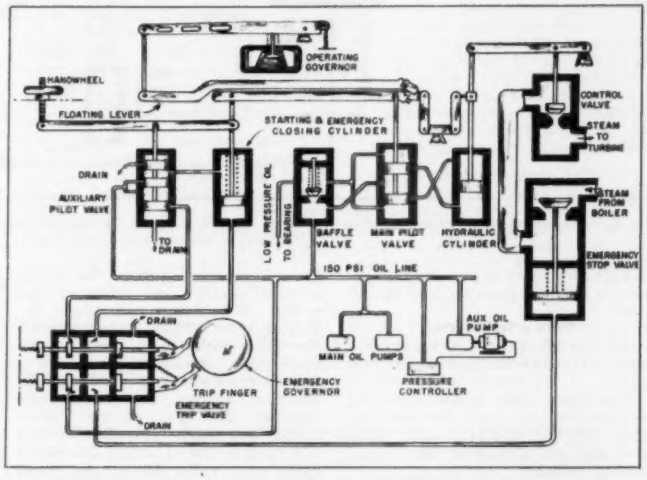


Fig. 5. To Fig. 3, we add the emergency trip valves operated by the emergency governor to control the automatic tripping mechanism and emergency stop valve. Now turn to Fig. 6 to see complete governor mechanism

*See also Oil Systems for Industrial Steam Turbines by Frank C. Linn, *Power Generation*, April 1949.

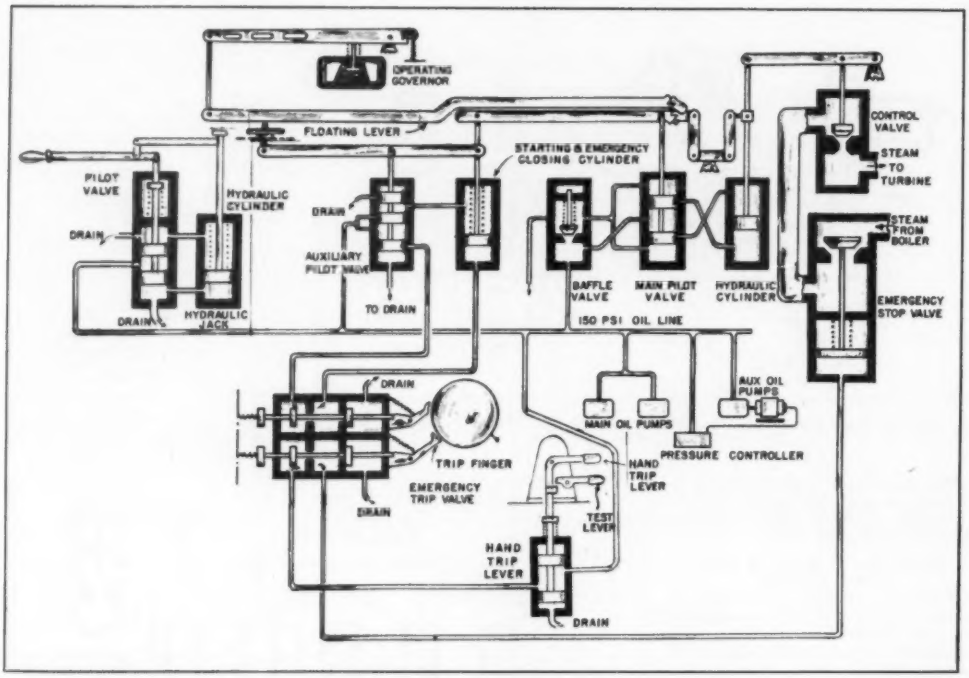


Fig. 6. To complete the governor operating mechanism, we add to Fig. 5 the hydraulic jack to check emergency governor, and the hand trip valve to trip emergency stop valve

so that they open in turn as the turbine is brought from no load to full load.

She's a Self-Starter

Now let's find out how the mechanism starts the turbine in the first place.

Two more units in the operating mechanism are used for starting. They are the auxiliary pilot valve and the starting and emergency closing cylinder.

As shown in Fig. 3, the piston rod of the starting cylinder is connected to the floating lever. The auxiliary pilot valve stem is connected to a lever which is fastened at one end to a handwheel, and, at the other end, to the starting cylinder piston rod.

The auxiliary pilot valve is similar to the main pilot valve, except that it has three disks on its stem. Normally, the lower disc controls the flow of oil to the bottom of the starting cylinder piston.

There is no throttle valve on this particular turbine generator. To start the machine, the handwheel on the auxiliary pilot valve lever is turned slightly. This pushes down on the auxiliary pilot valve stem. The disks move below their neutral position. As it moves down, the lower disk uncovers the port leading to the bottom of the starting cylinder. This allows 150-psi oil to flow in under the starting cylinder piston. The oil pressure pushes the piston upward against the force of the spring. The piston rod raises the floating lever, which, in turn, raises the valve steam and disks of the main pilot valve. This allows oil to flow to the bottom of the hydraulic cylinder, raising the piston and opening the first control valve. Steam can then enter the turbine and start it rolling, since the emergency stop valve has already been opened.

The lever connecting the auxiliary pilot valve stem and the starting cylinder piston rod acts as a compensating linkage. It works in the same way as the linkage which joins the hydraulic cylinder piston rod and the floating lever.

This compensating motion allows the operator to open the valves as much or as little as he desires when starting the machine. If he turns the handwheel only a small amount, the control valves will be opened only slightly. On the other hand, if he turns the handwheel as far as it will go, the valves will be opened all the way.

The operator, then, uses the handwheel just as he would the throttle valve on another turbine. He turns the handwheel slightly to start the machine rolling. He keeps turning the handwheel gradually to bring the machine up to speed. When the speed reaches about 1750 rpm the operating governor starts working. This means that the upper part of the floating lever has been lowered enough to contact the lower part of the floating lever, to which the starting cylinder is connected. The operator then turns the handwheel to its wide open position, and the governor takes over the regulation of the opening of the control valves.

There you have the turbine's operating mechanism. Now we'll take up the emergency tripping mechanism and see how it protects the turbine against overspeed and oil failure.

Tripping Mechanism

The emergency tripping mechanism protects the turbine against oil failure or overspeeding.

The emergency tripping mechanism can be roughly divided into: the automatic tripping mechanism, and the manual tripping and test equipment. The automatic tripping mechanism includes: 1. Emergency governor; 2. Emergency trip valves; 3. Emergency stop valve; and 4. Starting and emergency closing cylinder.

The emergency governor, Fig. 4, acts to cut off the steam to the turbine in case of overspeeding. It is of the unbalanced-ring type. It consists of an inner ring which is bolted to the turbine shaft and supports

(Continued on page 78)

Mobilizing Power — Here We Go Again!

What is MRO? . . . DO 97? . . . DEPA? . . . PED? . . . How do they affect your work as a power engineer? . . . The Editors boil it all down for you here, based on first-hand information gathered right in Washington and on study of the various NPA regulations now in effect . . . CMP to come in July

YOU'RE GOING TO hear more from now on about NPA and DEPA and PED and especially about MRO and DO 97. As a power engineer, you will probably be more affected by MRO regulations than by anything else, although if you're in an industrial plant your industry will be seriously affected by many others that will affect your power engineering activities in turn. If you are in a utility, DEPA will govern your destiny.

Also, in May you will begin to hear about CMP, which is to go into effect beginning July 1, 1951.

By this time, you will have recognized the above alphabetical jabberwocky as the initials of the new organizations established to handle the mobilization of industry. The setup is different from that used in the last war. Here's how it works.

No new and independent agencies have been created. Instead, new departments or authorities have been established under the existing Government Departments, subordinate to the secretaries of those departments.

Over-all co-ordination of the mobilization is by the National Production Authority, NPA, headed by Charles E. Wilson. This is set up under the Department of Commerce, headed by Secretary Sawyer.

Under NPA is a Power Equipment Division, whose duty is to see that manufacturers of power equipment receive raw materials, applied for by DO orders, with which to fabricate equipment.

Then there is a Defense Electric Production Authority, DEPA, an agency set up in the Department of the Interior, headed by Secretary Chapman. DEPA follows broad policies established by the Defense Production Administration under General Harrison and ultimately the top policies of Defense Mobilizer Wilson.

What DEPA Does

Function of DEPA is to determine what power plants are to be built, who will build them, when and where. It will determine how scarce materials are to be allocated to both privately and publicly-owned utilities.

DEPA is headed by Clifford B. McManus, former president of Georgia Power Co. and of Southern Co. He has two consultants, also the Electric Utility Defense Council appointed last October by Secretary Chapman. He has called in for his staff many utility executives and engineers, both from the privately-owned utilities and the Federal, public and municipal systems. Also this same type of top engineers and executives have been brought in from manufacturers of equipment and utilities to serve on PED in allocating raw materials.

How to Get MRO with DO 97

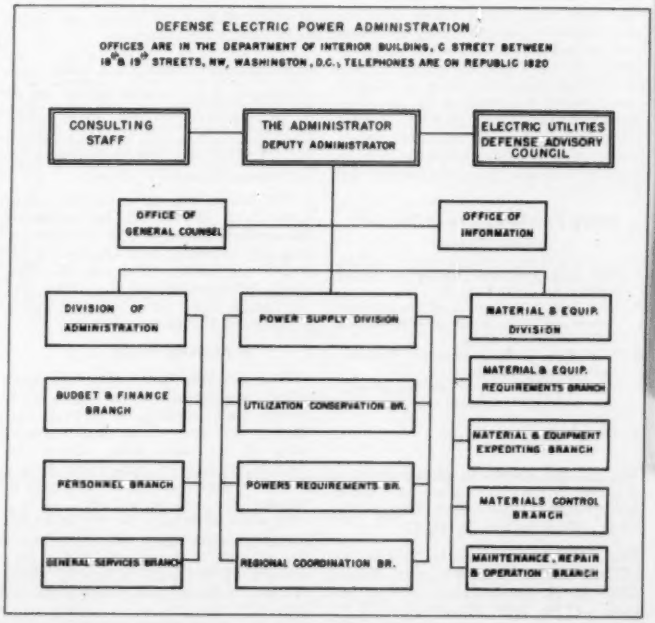
One of the most important actions of the National Production Authority to date, affecting every engineer in industry, is NPA Regulation 4 covering Maintenance, Repair and Operating Supplies and Minor Capital Additions. In effect, its objective is to make everybody get the most they can out of what they have, just as in the last war. This does not apply to new construction, which cannot be started anyway without NPA approval unless it contributes to the mobilization effort (except for certain construction and necessary repair and restoration).

But under Regulation 4, any industry is authorized to use a Defense Order rating called a DO and identified by the symbol DO 97, to obtain limited quantities of maintenance, repair and operating supplies as well as minor capital additions. You don't have to use the DO 97 but you may be unable to get anything without it.

After July 1, 1951, however, a Controlled Materials Plan, CMP, will be put into effect by NPA. Your particular industry will receive full information about it in May. At this writing, no details have been issued to show how the MRO orders will be affected by CMP but this will of course be clarified. But so far as we know now, it will all be handled through the existing NPA and DEPA organizations described here.

What Maintenance Means

Under Reg. 4, maintenance means minimum upkeep necessary to continue any plant, facility or equipment to sound working conditions when it has been rendered unsafe or


DEFENSE ELECTRIC POWER ADMINISTRATION
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CONSULTING STAFF
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OFFICE OF GENERAL COUNSEL
OFFICE OF INFORMATION
DIVISION OF ADMINISTRATION
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GENERAL SERVICES BRANCH
POWER SUPPLY DIVISION
UTILIZATION CONSERVATION BR.
POWERS REQUIREMENTS BR.
REGIONAL COORDINATION BR.
MATERIAL & EQUIP. DIVISION
MATERIAL & EQUIP. REQUIREMENTS BRANCH
MATERIAL & EQUIPMENT EXPEDITING BRANCH
MATERIALS CONTROL BRANCH
MAINTENANCE, REPAIR & OPERATION BRANCH

unfit for service by wear and tear, damage, failure of parts. Improvements are not included.

Operating supplies are any materials normally so carried according to established accounting practice.

What Is a Minor Capital Addition?

Minor capital additions under NPA Regulation 4 mean any improvement or addition carried as capital according to established accounting practice where total cost of materials used does not exceed $750 for any one complete capital addition. (Don't ask us what kind of capital addition you can buy for $750—we didn't write the regulation. A flow meter, perhaps.)

DEPA has 2 divisions: Materials and Equipment and Power Supply. Materials and Equipment Division will have these branches: Materials and Equipment Requirements; Materials and Equipment Expediting; Materials Control; Maintenance Repair and Operation. (Both utilities and production industries can use DO 97 orders for MRO supplies, but for the utilities they will be handled through the DEPA division.)

DEPA'S Power Supply Division will pass on the essentiality of proposed power construction. The division also has a Regional Co-ordination Branch, based on the 8 FPC regional divisions, with a member for each region, to maintain continuous studies of regional power.

Power Equipment Division of NPA has sections on boilers, condensers, conservation, Diesel and gas engines, hydraulic turbines, marine, pole line hardware, steam turbines, switchgear and transformers, electrical and power plant auxiliaries, also on program and statistics and co-ordination. On March 5, NPA Order M-44 required heavy power equipment manufacturers to submit order board information by the 15th of each month. Through PED, orders for equipment on a manufacturer's books may be canceled, changed or transferred, all as co-ordinated by NPA.

Every Power Engineer Should Have These

1. NPA Reg. 4, covering rating DO 97 for MRO supplies.
2. NPA Reg. 2, Basic rules of the priorities system and listing materials and products NOT subject to ratings.
3. NPA Reg. 1, Basic rules for inventory control and quantities.
4. Complete M-Order list covering some 22 raw materials and semi-fabricated materials.
5. List of NPA Field Offices.

WRITE for copies to National Production Authority, Office of Public Information, Room 5004, Commerce Bldg., Washington 25, D. C.

For DEPA information, write to DEPA Office of Information, Room 5452, U. S. Department of the Interior, C St., NW, Washington, D. C.

STEAM TURBINE GOVERNOR

(Continued from page 76)

the outer ring. At normal speeds, the spring holds the outer ring against the lock nut. Both rings and the turbine shaft rotate about the same center. When the turbine speed reaches about 1980 rpm, the centrifugal force of the weight overcomes the spring force. The spring is compressed and the outer ring moves about 7/16 in. off center.

There are two emergency trip valves. One is located in the line between the auxiliary pilot valve and the emergency closing cylinder. The other is in the supply line to the emergency stop valve. They are double-seated valves and are held in their normal or latched position by the trip fingers. When the fingers are unlatched, oil and spring pressure moves the valves to the right.

The emergency stop valve is installed in the main steam line ahead of the control valves. The valve is held open by 150-psi oil acting against a spring-loaded piston.

What Happens if Turbine Overspeeds

Now let's see how these units act if the turbine overspeeds. Nothing happens until the speed reaches about 1980 rpm. At this point the emergency governor moves off center as previously described. This movement causes it to strike the trip fingers. The trip valves are unlatched, and oil and spring pressure moves them to the right.

When the upper valve moves, it closes off the supply of oil to the bottom of the emergency closing cylinder piston, and allows the oil already under the piston to drain back to the oil reservoir.

Since the auxiliary pilot valve is in the wide-open or all-the-way down position, its disks are in such a position that oil pressure is still exerted on the top of the emergency closing cylinder piston. The oil pressure, plus the spring force, pushes the piston down. This pulls the floating lever down, causing the main pilot valve to move down. Oil flows to the top of the hydraulic cylinder piston, pushing it down and closing the control valves.

The lower trip valve moves at the same time. It cuts off the supply of oil to the bottom of the emergency stop valve piston, and allows the oil under the piston to drain off. The steam pressure above the valve and the spring force close the stop valve, cutting off the steam supply.

If Anything Sticks . . . ?

It is possible that either the stop valve or control valves might stick in the open position. It is very unlikely, however, that both would stick at the same time. Since the emergency acts to close both, it is a sure bet that the supply of steam to the turbine will be cut off.

In case of failure of the main oil pumps, the pressure controller starts the auxiliary pump when the hydraulic oil pressure drops to about 115 psi. If the auxiliary pump should also fail, the pressure would continue to drop. The drop in pressure underneath the emergency stop valve piston would allow the steam and spring pressure to close that valve.

With its supply of steam cut off, the turbine would come to a stop before too much damage was done.

Checks on the Tripping Mechanism

Most turbines have equipment built into them to check the operation of the tripping mechanism.

A hydraulic jack is used to check the speed at which the emergency governor trips the machine. This jack consists of a pilot valve and a hydraulic cylinder. The pilot valve is connected to the 150 psi oil supply line.

Operation of the emergency governor is tested with no load on the machine. The operating governor then holds the speed at 1800 rpm. A tachometer is used to check the turbine's speed.

Raising the jack handle pushes the pilot valve stem down. The lower disk moves down below the bottom port. This allows 150 psi oil to flow under the hydraulic cylinder piston. The piston and rod start rising. The rod pushes against the floating lever, overcomes the operating governor and forces the lever above its normal position.

This moves the main pilot valve up, causing the hydraulic cylinder piston to rise and open the control valves. The increased valve opening allows more steam to enter the turbine.

The extra steam causes the turbine to speed up until it reaches the point where the emergency governor trips it. The speed of the turbine at this point is read from the tachometer. It shouldn't be more than ten per cent, or 180 rpm, above normal.

Manual Trip

The hand trip valve is used to trip the emergency stop valve manually. It is also used to check the stop valve to make sure that the valve moves freely. It is located in the oil supply line to the emergency stop valve piston.

The valve is latched in its normal position by the hand trip lever as shown in Fig. 6. In this position, oil flows freely through it. When the hand trip lever is moved, the valve is unlatched, and the spring forces it upward. The lower disk moves to a position between the inlet and outlet ports.

This cuts off the oil supply and uncovers the drain port. The oil beneath the stop valve piston drains off and steam pressure and spring force push the piston down. The stop valve closes and cuts off the steam to the turbine.

The test lever on the hand trip valve is used to make sure that the emergency stop valve moves freely. Raising the handle of the test lever pushes the valve stem down. The upper disk moves down so that it covers the inlet port. This cuts off the oil supply to the stop valve piston. The drain line remains closed, though, so that the oil pressure beneath the piston is not released.

However, there is enough leakage past the stop valve piston to allow the piston to move slowly downward. As soon as it is apparent that the valve is closing, the test lever is released. The spring pushes the valve back up to its normal position. This allows oil to again flow to the bottom of the stop valve piston. The oil pressure moves the valve back to its wide open position.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

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IT CAN EASILY HAPPEN IN YOUR PLANT

On the next page, we present an interesting account of a situation which will probably strike a sympathetic chord in those who have encountered similar crises involving human relations. Mr. Lindgren, who wrote the article, asks whether it could happen in your plant. He need not have asked the question because the problem he presents prevails wherever individuals are in competition with each other, and situations such as he describes arise practically everywhere. And, sadly enough, there is probably no solution. The trouble lies not so much with the individuals concerned as with the pattern of our industrial operations; indeed, it goes beyond that: it is a result of our pattern of culture. It stems from the great value we place upon individual, personal superiority. We expect rewards for individual superior attainment whether it be real or false. Quite often, particularly in the executive branch of the art, it is not real, and that increases the seriousness of the situation.

If, in the conduct of business and manufacture, rewards were made on the basis of group accomplishment rather than on personal skill or repute, situations such as Mr. Lindgren describes would not arise. There would have been no reason for the engineer to hesitate in taking the practical man's advice since he would have known that it was offered solely in the interest of the organization as a whole.

These problems cannot be resolved by appealing to human nature. Human nature is not an unvarying quality. Human nature manifests itself differently under different sets of circumstances. Attributes which are valued in one type of culture have no significance in another, and in two such differing cultures the same stimuli will result in expressions of human nature that will vary in accordance with the values placed on personal qualities. There are cultures, such as the Hopi in the southwest, where the situation Mr. Lindgren describes could not occur, but, in your plant, you can be certain it can.

AWK

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A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
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Could This Happen in Your Plant?

Here is a true story of a situation that arose in a steel mill which describes certain aspects of human relationships that can cause considerable damage and personal enmity

By GILBERT LINDGREN

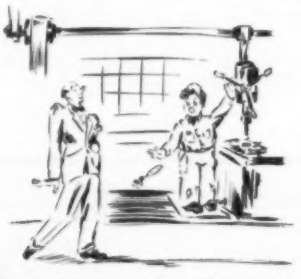
WE HEAR a lot about the underground in politics and in other phases of our social life—its disturbing influence and costly disruption of well-laid plans. There is another underground of which we seldom hear but which goes on every day in our industrial life with equally disturbing and costly results. It is the petty wrangling and sometimes serious misunderstanding which develops between the practical minded foreman or supervisor and the technically trained engineer or technician.

The basic cause of this underground feud is the natural resentment we all seem to possess against unasked-for advice. Even when asked for, it must be delivered with the traditional silk glove delivery. The more skilled the craftsman—practical or technical—the more pride he has in his ability, and that pride is his most sensitive spot. If you want to put this fact to test just try telling a highly skilled tool or die maker how to make that tool or die. Try to tell an engineer who knows his business how to handle details.

When these two artists are brought together to work out some industrial problem, traffic lights must be obeyed, each must be willing and able to appreciate the other's point of view. That's a big order for most of us.

Here is a true story—written in the first person in order to more clearly illustrate the several points.

Assistant Chief Engineer Mr. I. M. Big was a graduate of one of our best engineering schools, indeed he had often reminded me of this fact. As an engineer he was good, this I had to admit. He wore the best of clothes, always, and his signature was his very own. New employees or strangers seeing him walk through the plant always over-estimated his position, he had that air of importance. His nod of recognition was in direct proportion to the recipient's position in line of authority, the helpers or sweepers being ignored altogether. In short, a capable engineer with the self-confidence to go ahead and do a job without looking for a lot of practical advice.



New employees seeing him walk through the plant—

Working under him I had often reminded him of the fact that I had graduated from the University of Hard Knocks; that I had been in and out of many a mill problem before he had worn long pants. Mr. Big always called attention to the mistakes in my sketches and tried to help me develop a better vocabulary but this only aggrevated my dislike for him. I, in turn, lost no time in beating my chest when I could prove that I was right and he was wrong, which of course failed to strengthen his love for me.

At last came the eruption. The Chief Engineer was in a hospital bed which put my friend in full charge. A note came to my desk—"See me at your earliest convenience—I.M.B." His desk was at the far corner of the room, you couldn't sneak up on him.

"I'm going to change the hoist control on No. 1 crane to semi-automatic, the same as No. 2. I'll have the construction gang do the work on Sunday when the mill is down so that it won't interfere with your regular repair work."

"Why change that control? It's the best crane we have; fast and much easier to shoot trouble on than No. 2. I think you better leave that crane alone."

"Well," he replied, "unless you have a much better reason than that, we'll go ahead with the job. I also expect you to give the construction foreman whatever assistance he may need in the final hook-up, and, remember, keeping that mill running is still YOUR responsibility."

I could feel my blood pressure rising—"Do whatever you like, it's your baby" I said, and left the office. I knew that this new control would slow up the ingot delivery to the mill; that the only reason the operators did not kick too much about No. 2, was that we were able to make up for lost time by using No. 1, but why point out this fact to him, he was getting paid for doing all the thinking. I also knew that next Sunday No. 1 crane would have to start charging due to repairs under No. 2 and that they were going to try out a larger ingot. Let him get off his can and come out in the mill and find out these things for himself.

Sure enough, Sunday morning the construction gang arrived, took off the old manual controllers and installed the new panels. I took extra

He always called attention to the mistakes in my sketches

care to stay away from the job until about 5 o'clock in the afternoon. The mill was due to start at 6 p.m. so about 5:15 they called the operator to try out the new control. Old Crabby Lew made one run to the pits and back. "Who do you expect to run that mud turtle? She won't even *lift* that new ingot, much less carry it. How are you going to start rolling?"

"What are we going to do?" the construction boss turned to me.

"Call your boss and ask him, I told him to leave that crane alone."

I went back to the shop, sat down at the desk and began to think. I knew I was to blame for this mess. The phone rang, it was I.M.B. "What's wrong with No. 1 crane?"

"I told you the other day it wouldn't work, it can't handle this new heavy ingot."

"A new ingot? Why didn't you tell me about the new ingot? Well, put the old manual controllers back on the crane, hook it up temporary, they can use No. 2 while you change back."

"They can't start the—" I hung up without finishing.

"The lousy b--t--d—he dumps the whole thing right in my lap, 15 minutes to do a 3 hour job."

The door flew open, the night superintendent stood there.

"What about No. 1, they tell me we can't start at six?"

I couldn't answer, my throat was plugged tight, I could feel a cold sweat coming on. The "super" must have thought I had gone nuts, he swung around and left. Three of my men stood around but said nothing, finally they walked out leaving one of the helpers.

In less than three minutes the phone rang again, it was the plant manager calling from his home. "Listen," he said, "cut out all that baby stuff down there and get that mill running, and if you know what's good for you, you won't quit until that crane is operating, do you hear?"

"Yes sir."

"All right Ed," I ordered, "Get the rest of the gang and let's go up on No. 1." The helper disappeared as if by magic. When I got to No. 1 the construction foreman asked, "Can I give you a hand?"

"Take your whole outfit and get out of here," I answered. A few of the mill gang stood around but there was none of the usual ribbing we had to take whenever we held up production for a few minutes. They all seemed to know that I was just about ready to bust. We had about fifty connections to make, most of them wrong the first time. I was so mad I actually cried; no gang ever worked in such complete silence. At 8:30 pm we finished—2½ hrs. delay —about 200 tons of finished steel lost.

The next morning the plant manager stopped in to have a talk. Two weeks later when the Chief got back to work we had a meeting of all the field supervisors and the engineering staff. Two individuals had learned a few lessons the hard way. There might also have been two unemployed with no good references from their former employers, but we were lucky.

Could this happen in your plant?

Don't Damage Tubes by Over-Rolling!

PRACTICALLY all boiler tubes have the ends expanded into the tube holes of the drum or shell. Numerous unfired pressure vessels also are equipped with tube sheets that require expanding the tubes into the tube holes. The expanded joint should be leak-proof and at the same time it should give the tube substantial holding or staying power.

The outside diameter of the tube is usually 1/32 in. less than the hole diameter for watertube boilers and 1/32 in. less at the fire end, with 1/16 in. less at the opposite end for fire-tube boilers. The greater clearance in the latter instance is to prevent binding of scale coated tubes when they are removed for replacement. The ASME Code requires that the ends of the tubes in water-tube boilers project beyond the tube sheet a minimum of ¼ in. and not over ½ in. The ends of the tubes should be flared to ⅛ in. more than the diameter of the tube.

The flaring of the tube ends is required by the ASME Boiler Code and it is considered necessary as a protective measure against the tubes' pulling out. Also, tubes that are flared offer less resistance to the flow of water and steam than those that are not flared. The flaring at the end of the tube is accomplished by using an expander having extra belling rolls and usually equipped with a skirt to control the depth of the flare.

Several types of expanders are available and a common type uses three rolls which fit into the tube end with a tapered mandrel between the rolls. The expanders may be hand operated, motor or air driven.

The contrast between a 4½ in. tube expander and a ¼ in. tube expander is shown in the illustration on this page. The extent of the damage to the wall of the tube or tube hole from over-rolling will be the same regardless of which size expander is used, the reason being that the wall thickness of the tube or hole will vary with the size of the expander.

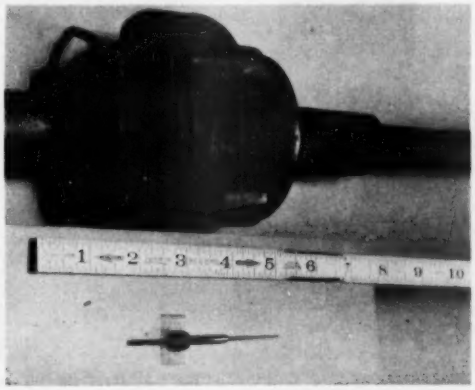
During the days of hand rolling, little significance was given the job of rolling tubes. The tubes were usually rolled just enough to obtain tight joints and little or no damage was done to the tube wall or tube sheet. With use of power-driven tube expanders to facilitate the rolling of heavy wall tubes in thick tube sheets, the possibility of over-rolling and damaging the metal by cold working becomes greater, according to an article in the February issue of *The Condenser* of Mutual Boiler and Machinery Insurance Co. Having no satisfactory means to determine the amount of rolling required, it is usually left up to the judgment of the operator. The operator's lack of knowledge as to what constitutes an ideal joint and the fact that it is impressed on him to make a tight joint often leads him to over-roll rather than under-roll the tube ends.

When using power expanders on thin wall tubes and tube sheets, serious damage may result to the metal in the tubes and tube sheets with enlargement of the tube hole.

Rolling of boiler tubes increases their length. When one end of the tube has been firmly attached to the tube sheet by rolling, the expanding of the other end has a tendency to force the tube sheets apart a distance equal to the amount of the elongation of the tube. If the tube is of considerable length, whether straight or bent, and the tube sheets rigid enough so that they will not give, the internal stress set up in the tube due to elongation will be taken up by bowing of the tube. Extrusion of the free ends of boiler tubes also takes place during rolling. The amount of extrusion should be negligible in a properly rolled joint.

With rigid short tubes, the elongation cannot be disposed of as easily; therefore, if the tube is stiff enough to resist deformation, some other part of the structure must yield.

When a tube is severely over-rolled, work hardness occurs and other physical properties are changed. The results of tests from reliable sources show that as the



Contrast between a 4½-in. tube expander and a ¼-in. tube expander. Wall thickness of tube varies with expander size, hence damage from over-rolling is the same

amount of rolling is increased, the hardness of the inner surface of the tube rises very rapidly, while the outer surface hardness increases slowly. The reduction in tube wall thickness is in proportion to the amount of rolling.

Over-rolling of this nature cold works the metal to such an extent that its ductility is greatly reduced. Surface tears may occur and resistance to corrosion is reduced.

Special attention should be given to the rolling of tubes regardless of size, and the operator employed should be properly trained in tube rolling techniques and work under the supervision of someone experienced in this line.

Boiler Tube Sheet and Shell Repair

Here is a description of a repair job that seemed almost hopeless at first but when finally given enough thought was carried through to success

By M. J. HURD
The Geo. T. Stagg Co., Division of Schenley Products, Inc., Frankfort, Ky.

THE REAR TUBE sheets and shells of our HRT boiler had deteriorated over the general areas indicated by the cut-out shown in Fig. 1 to such an extent that our insurance company recommended immediate replacement of the boilers. The boilers were in a generally poor condition, having been in service since 1909, with insufficient setting height and other features that ordinarily would have helped to justify their replacement. However, the year was 1945, replacements were scarce, and considerable production would have been lost awaiting delivery and installation of the replacements. The plant was just starting a scheduled idle period for general overhaul and maintenance, and production had to be resumed at the specified time.

With replacement in the allotted time out of the question, repair seemed to be our only solution and with this in mind a check inspection was made by a senior inspector of the insurance company and he agreed that if the defective tube sheets and shell sections were replaced or repaired the boilers could be used for further service at regular pressure.

Our first thought along the lines of repair was to remove the boilers from the settings and take them to a shop approximately 50 miles away for replacement of the shell rings and tube sheets. This, of course, would have insured an A-1 job under the best of working conditions for the mechanics. It soon developed however, that this would be as time consuming as awaiting replacement with new or used boilers.

We then considered replacement of the affected parts on the job, but since this meant tearing out a large part of the settings and preparing for and driving a great number of rivets on the job, repair in this manner was also eliminated because of the time it would have taken.

Obviously, patching of both shells and tube sheets seemed to be the only answer, but the method to be used in patching the flue sheets puzzled us until someone recalled seeing a rear tube sheet patch, containing several tube holes, made by cutting across the ligaments and welding in a patch with tube holes already made. This patch had not included the riveted head seam, as ours would, but after consultation with the insurance company and a skilled boiler-maker and welder, it was decided that such a repair could be made successfully, and in the required time. Work was started immediately and we followed this procedure:

All tubes and the through stay-rods were removed to make working space inside the shells. The rear arches and the upper part of the rear combustion chamber walls were removed to make working space outside, and the tube sheets and shells cut as shown in Fig. 1. The cut-out pieces were then taken to the shop for patterns and the replacement pieces made—with steel half-couplings welded into the shell patch pieces for blow-off connections—and returned to the job for fitting and welding in place.

It was here that we ran into the only real difficulty in the whole job. The part tube holes in the tube sheet patches would not match the part holes left in the old sections of sheet remaining in the boilers, thus throwing these holes badly out of round as shown in Fig. 2, tube

Fig. 1. General view of rear tube sheet, showing section cut out

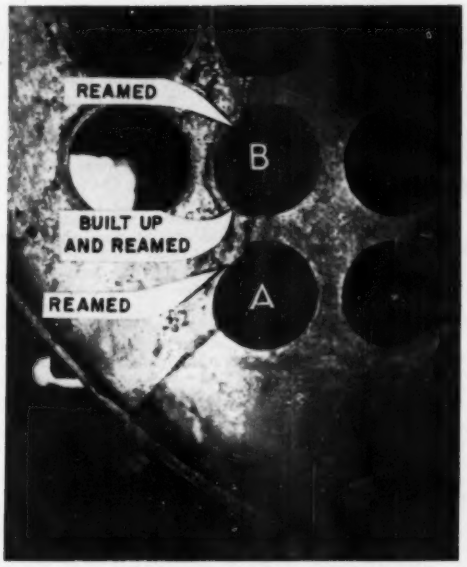
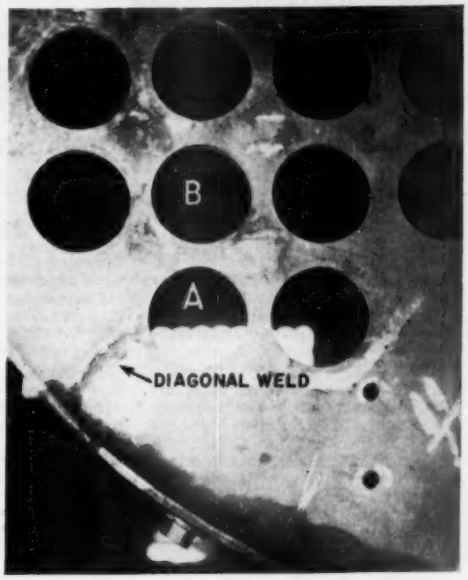


Fig. 2. (Above) This shows how the parts of the holes in the old section of the tube sheet would match the parts of the holes in the new part of the tube sheet

Fig. 3. (Below) View of the finished repair, after holes had been built up with weld metal and ground to size



holes A and B. The only possible way of rounding up these holes to proper size and without reducing the ligaments, was to build up all low points with weld metal and then grind and ream the holes to size. This was done with results as shown in Fig. 3, in which holes A and B are the same holes marked A and B in Fig. 2.

The failure of the partial holes in the tube sheet patch-pieces to meet the partial holes in the tube sheet pieces left intact, was due to an oversight by the shop lay-out man in not laying out the boundary or partial holes individually from the corresponding holes in the old sheets. Instead, he used a template carrying all holes in each vertical and horizontal row on the same center line and his center lines did not agree with all the old holes as some of these had been made off-center due to the inaccurate methods used back in the days when the boilers were built.

In Fig. 3, all ligament welds have been made and ground down, the diagonal weld from the head seam to hole A has been made and ground down and the shell patch weld has been made. All that remained was simple, involving only the standard repair work of removing and replacing certain rivets close to the diagonal welds; preparing for and driving the few rivets in the patch sections; replacing stay-rod attachments, rods and tubes; and stress relieving the shell patch weld.

The job was completed, with proper hydrostatic tests and setting repairs, in time to meet the deadline. The repaired boilers have given satisfactory service to this time and from all appearances are good for considerably more service. They have been approved without restriction after each annual inspection by our insurance company.

Emergency Socket Wrench

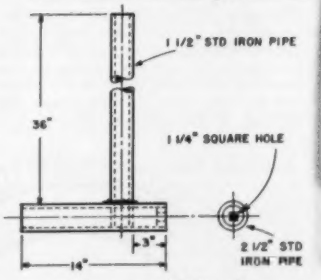
By ALBERT MOULTON

A SMALL HEATING BOILER of the water tube type, had for tube access openings, holes of 2 in. pipe size and closed by 2 in. pipe plugs. After a few years this boiler was sold and moved to a new location and it was found necessary to renew a few tubes and also give it a thorough cleaning and overhauling before putting it again in service.

This, of course, made it necessary to remove all plugs to get at the tubes. This proved to be a major operation, for these plugs were really "frozen" in, not just a chill but a "deep freeze" and for a time defied all efforts to stir them. First penetrating fluid was applied and left to soak for several days, but still every kind of wrench available, strong enough to hold the force applied, just popped off the plug heads which were 1¼ in. square with a slight variation in size.

It was evident that this job called for a special socket wrench that could take it, and when none could be found in the local supply houses, it was decided to make one. A piece of steel plate ½ in. thick had a 1¼ in. square hole cut in it, and then was cut by torch to fit into one end of a piece of 2½ in. standard pipe 14 in. long. A piece of 1½ in. pipe 3 ft long was arc welded on for a handle as shown in the sketch.

This wrench did the job and all plugs were removed and none were broken, in spite of a boiler maker's prediction that they would all have to be cut out and new plugs put in. The saving in cost of plugs alone more than paid for the wrench.



Emergency Socket Wrench

THE PRACTICAL ENGINEER AND ELECTRICIAN

Maintaining Good D-C Motor Commutation

Inspection and cleaning . . . Oiling . . . Replacement of brushes . . . Checking the commutator . . . Care of the commutator . . . Use of commutator grinder . . . Significance of severe sparking

By THOMAS TRAIL

THE GREATEST SINGLE problem in the maintenance of direct current motors is commutation. Satisfactory commutation requires frequent checkups and regular periodic maintenance, in order to compensate for wear, discover defects and prevent small troubles from rapidly developing into big troubles.

The first necessity for good commutation is cleanliness. The motor should be cleaned of accumulated dust once a week. Medium pressure compressed air is best for this purpose, but in its absence a portable electric blower or even a hand bellows will suffice. The motor windings should be blown free of dust by directing the air against them from the commutator end of the motor. Then the commutator and brush holders should be cleaned by blowing from the back of the commutator toward the front or bearing end.

Each brush should then be checked for length, and removed from its holder, cleaned with a dry cloth, and returned to the holder. Where brushes show evidence of having a greasy appearance they should be cleaned with a cloth moistened with carbon tetrachloride. In this case the brush holders should be cleaned in the same manner. If greasy deposits are present on the commutator, do not replace the brushes but block them in the holders so that they do not touch the surface of the commutator.

Then clean the commutator surface and segment slots carefully with carbon tetrachloride. This may be applied with a cloth to surface deposits, but those lodged in the segment slots will have to be scraped out. It is usually better to remove such deposits before applying the cleaning fluid to the commutator. The deposits will then be drier and more easily removed. A knife blade, hacksaw blade with the teeth ground off, or a similar tool may be employed in cleaning the commutator slots. After all slots have been cleaned, use a small stiff bristled brush dipped in carbon tetrachloride to brush out all the slots, brushing from the back of the commutator to the front. Finish by cleaning the commutator surface with a cloth moistened with the cleaning fluid. A dry brush, or a dry cloth wrapped around a knife blade, should be used to wipe the segment slots dry, after which the commutator surface should be wiped clean and dry with a cloth.

Next examine the V ring end of the commutator for greasy or oily deposits. Deposits here indicate that lubricant is escaping from the bearing in liquid or vapor form. From the V ring end of the commutator assembly the oily film gradually works its way to the commutator bars and slots. For this reason, it is necessary to prevent the escape of lubricant from the bearing housing, if possible.

Lubricant escape can be caused by one or more of several factors. The oil or grease seal of the bearing may be worn or defective, thus permitting lubricant to escape and follow the rotor shaft to the commutator. The remedy for this is to remove the motor end bell and replace the felt or grease lubricant seal, being sure to carefully remove any traces of grease or gumminess from the surface of the rotor shaft that rests against the lubricant seal, so as to insure as tight a fit as possible.

It is also possible for lubricant to be siphoned from the bearing in the form of vapor, by vacuum resulting from windage created by the spinning rotor. Some more modern motors are equipped with by-pass vents that are designed to eliminate this vacuum formation. On motors not so equipped there is little that can be done to prevent siphoning of the lubricant, though some mechanics experiment with such remedies as threaded cover oil level gages, tightened filler plugs, loosened filler plugs, etc. The best remedy for preventing lubricant reaching the commutator in this manner is to wipe off the bearing housing inside and outside the end bell, the recessed portions of the V ring end of the commutator assembly, and any part of the shaft outside the bearing. This should be done weekly with a dry cloth, or one moistened with cleaning fluid where necessary. This procedure will prevent any lubricant that escapes from the bearing accumulating from week to week and finally creeping onto the commutator surface.

When motor bearings are refilled with oil, be sure not to fill them too full so that they will overflow. Oil dripping from the bearing will add to the possibility of lubricant being drawn into the motor in the form of vapor. The same precaution should be observed when lubricating anti-friction bearings. The housings of ball and roller bearings should not be filled more than 1/3 full of grease. Where oil is used as the lubricant the same precautions apply as to any oil lubricated motor bearing.

Motor brushes wear gradually and at intervals require replacement. It is important that brushes never be allowed to wear down until they no longer rest on the commutator. Un-

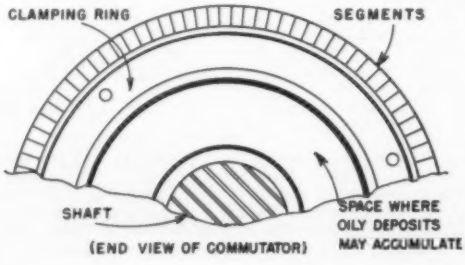
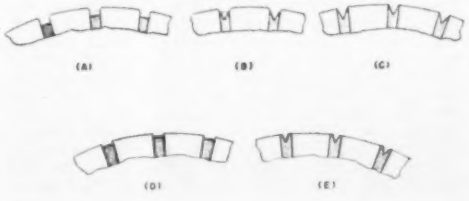


Fig. 1. End view of a commutator

Fig. 2. Sections showing condition of mica



less pressure contact is maintained between the brush face and the commutator surface heating and sparking will result, and if this condition is permitted to continue for even a short time severe sparking and flaming will occur, which will seriously damage the commutator. The writer recalls an instance where such neglect resulted in the flames from the brushes arcing over to the

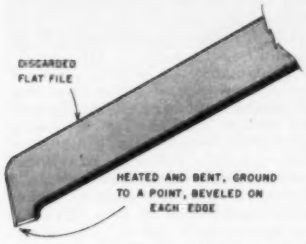


Fig. 3. Simple scraper made from a discarded flat file

copper strap armature coil leads on a 30 hp motor. The leads burned off in a short-circuit flash and explosion that could be heard over the entire floor of the building. The result was that the armature had to be completely rewound at a cost of $150.00, a high price to pay for the neglect of an hour's work. Furthermore, since poor contact at one brush will overload other brushes, these, too, will overheat and cause additional damage.

In replacing brushes it is usually preferable to replace all brushes at the same time. This insures equal contact pressure on each brush, provided the brush holder spring pressure is adjusted equally on all brushes. It also eliminates the inefficiency, especially on motors employing a number of brushes, caused by a policy of replacing one or two brushes at a time.

When installing new brushes be sure to use the exact same size, make and type as those being replaced, unless, of course, a different kind has been recommended by the motor manufacturer or a reputable brush application engineer. Sometimes this is necessary in order to overcome some commutation difficulty. It may be required where a flush mica commutator has been changed to an undercut type. While the former type of brush would probably continue furnishing satisfactory commutation in such a case, a less abrasive type might be indicated as a means of eliminating unnecessary wear on the commutator.

Before removing an old set of brushes, note how they are operating. Hold a dry stick lightly against the pressure arm of each brush holder on one stud to determine whether any chatter or vibration exists. The brushes should operate without any discernible vibration or motion in the holders for best commutation, though a small amount of vibration may be tolerated as long as it causes no sparking. But any pronounced vibration is a signal that the commutator requires resurfacing, and, if possible, this work should be done before installing a new set of brushes. Resurfacing may be done by turning the commutator in a lathe or grinding it with an adjustable grinder.

When installing a new set of brushes, it is always a good idea to carefully examine the commutator first to determine whether or not it requires attention. A certain amount of longitudinal waviness is not seriously objectionable, but if the waviness is very noticeable the commutator should be resurfaced. Otherwise, end play in the rotor may cause the brushes to ride the ridges on the commutator, thus reducing the brush face area in contact with the commutator surface.

The commutator should also be checked for burned, discolored or flat places. If any are found, the commutator should definitely be resurfaced, as explained previously. If this is neglected the burned or discolored places may develop into flat places, with the result that sparking will occur as the brushes are caused to vibrate by the commutator's unsymmetrical surface. This will aggravate conditions and lead to a burned and blackened commutator. Another condition that sometimes develops is an out of round or elliptical commutator. This condition, too, calls for resurfacing as a corrective measure, since it will cause and up and down movement of the brushes in their holders and consequent wear of the brush sides. This will result in loose brushes and unsatisfactory commutation.

Examine the slot mica carefully whether the commutator is undercut or not. Evidences of high mica will be a blackening across each commutator bar near the mica. This condition produces sparking which will become progressively worse, and if permitted to continue will cause complete blackening of the commutator. On non-undercut commutators the remedy for high mica is a light resurfacing of the commutator with an adjustable grinder. It is also advisable to afterwards contact the motor manufacturer and obtain his advice as to whether the commutator should be undercut to prevent a recurrence of such troubles, or whether a more abrasive grade of brushes should be employed to keep the mica ground down.

If the slot mica on a V type undercut commutator is at or near the surface, as shown at (c) in Fig. 2, very often a pocket knife blade can be used to remove the slivers of mica from the sides of the segment slots, thus eliminating the need for re-slotting the mica. But when the mica is in the condition shown in Fig. 2, at (d) and (e), re-slotting is necessary.

Mica may be cut below the surface of the commutator segments either by hand or power filing, or by means of a power driven rotary saw. For small motor commutators hand filing is usually satisfactory, though slow. On most medium and large motor commutator undercutting with power file or saw is generally employed, with the saw probably being preferred. These motor driven saw blades are small in diameter and can be had in either U shape or V shape, and in a number of widths to suit various thicknesses of slot mica. The U shaped slot is preferred by some mechanics because of the elimination of mica slivers left by the wearing down of the copper segments. The V type slot is usually employed where slower speed might permit dust to lodge in the straight-sided U shaped slot. However, the writer personally prefers the V slot for several reasons. First, its shape automatically permits a small bevel to be cut on the edges of adjacent commutator segments, as shown at (b) in Fig. 2. This eliminates square edges at these points and thus makes them more self-cleaning. Any small irregularities in the slot may easily be corrected with a triangular file. And as has been explained previously, this type of slot offers less opportunity for lodgement of dust, especially carbon dust from the brushes, than does the U type slot shown in Fig. 2 at (a).

In slotting mica, particularly when using a power cutter, care must be observed to avoid damaging the commutator surface. Hold the machine steady so as to prevent the cutter from jumping out of the slot, and be sure that the cutter is cut-

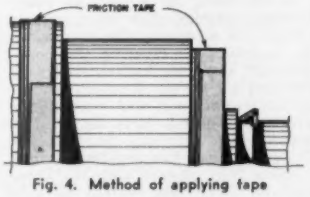


Fig. 4. Method of applying tape

ting exactly in the center of the mica so that the mica will be shaped uniformly. Where the undercutter is equipped with a guide, check frequently to see that the guide has not loosened or changed its position. Also examine each slot to see that the guide setting is correctly guiding the cutter. A very slightly incorrect spacing of the guide will have a cumulative effect in causing off-center slotting, since the discrepancy will be increased each time a slot is undercut. If this is not carefully noted the cutter will commence to cut into the copper at the side of the slot instead of cutting the mica.

After all segment slots have been undercut, it is well to examine each one to see that it is satisfactory. Any remaining mica slivers or other irregularities may be corrected with a narrow file or a pocket knife blade.

Next, lightly scrape the edges of both copper segments adjacent to each slot using a simple scraper such as is shown in Fig. 3. This will slightly round the segment edges and provide a smooth path for the brushes.

After all work on the commutator has been completed, go over the surface with very fine grit sandpaper or abrasive cloth (not emery) until it is very smooth. Then brush out each segment slot carefully with a small stiff bristled brush, brushing from the back of the commutator toward the front or V ring end. Examine each slot after brushing to see that it is entirely free of copper chips or other foreign material. A thin knife blade is convenient for removing such objects.

In order to protect the coil leads at the back of the commutator, and the binding cord at the front end, from being damaged by undercutting tools, it is advisable to wrap each end of the commutator with several layers of friction tape, as shown in Fig. 4. This precaution will also serve to prevent metal chips from lodging at these locations. After the undercutting has been finished, the tape should be removed and any remaining chips brushed out, or blown out with compressed air.

When using an adjustable commutator grinder, care must be exercised in mounting the device, so as to insure its clearing the commutator and all current-carrying parts at all times. A severe short-circuit can occur if such precautions are not observed. It is also important to prevent any part of the device, except the grinding stones, coming into contact with the commutator. The feed should be slow so as to exert a minimum force against the commutator. This will prevent distortion and damage to the commutator segments and mica. Grinding should be done by moving the stones all the way across the commutator surface each time they are moved forward. At the end of travel of each cut, the stones should be backed away from the commutator slightly and returned to the opposite end of travel for the next cut. It is better to cut only in one direction of travel. This will prevent unevenness of the commutator surface due to lost motion in the device.

If a considerable amount of metal needs to be removed from the commutator, coarse or medium stones should be employed at first, until a uniformly bright surface is obtained, then the use of fine or finishing stones, followed by polish stones, will produce a very smooth and satisfactory surface.

When an undercut commutator is refinished by grinding, it may afterwards be necessary to re-undercut the slot mica. If this is not required, however, it will be necessary to go over each slot with a narrow file or knife blade, to remove copper that has been dragged across the segment slot edges by the grinding operation. The segment edges will then need to be lightly scraped with a scraper, as explained previously.

Safety precautions should be observed when grinding or undercutting a commutator. These should include wearing shatterproof goggles and a dust respirator and having adequate ventilation. Both of these operations produce dust, and there is always danger of possible flying metal, mica or abrasive stone chips.

When replacing brushes it is important to accurately fit them to the curvature of the commutator. This is best accomplished by sanding the brush faces with sandpaper or abrasive cloth strips, as shown in Fig. 5. The abrasive material is used between the brush face and the commutator surface, with the grit side toward the brush face. A fairly coarse grit should be used at first to rapidly shape the brush, followed by a very fine grit to give the brush a smooth surface. The maximum amount of brush holder spring pressure should be applied to the brush to save grinding time. Often it will be found that considerable time can be saved by having a second person apply additional pressure to the brush with a finger. Since grinding should take place only in the direction in which the commutator rotates, the second person will be available to raise the brush each time the abrasive material is returned to the starting position. Be sure not to use emery cloth for sanding brushes.

After sanding, the spring pressure should be set equally on each brush. Approximately 1½ pounds pressure per square inch of brush face area is generally considered satisfactory for carbon brushes. By calculating the surface area of a brush, the correct pressure for that size brush may be determined. For example, a brush ⅜ inch thick and 1¼ inches wide would have an area of almost ½ square inch (⅜ × 1¼ equals ⅜ × 5/4 equals 15/32). 1½ pounds divided by ½ equals ¾ pounds or 12 ounces. A small spring weighting balance, with a loop of string to be hooked under the pigtail shunt loop of the brush, is very convenient for adjusting brush pressure.

It is not necessary to check the pressure on each brush where all brushes are the same length. Simply set the spring pressure adjustment on all brush holders at the same point and test each brush to see that it moves freely in the brush holder, as shown in Fig. 6. If a brush is sluggish, examine the holder brush box for roughness or burned spots. Such defects may be removed by the careful use of a file, as shown in Fig. 7. The brush holder should be removed from the motor for this work to avoid getting metal dust on the commutator. If no roughness or projections are found on the brush holder, sandpaper the surface of the brush slightly to reduce its size. This may be done by holding the brush flat on sandpaper that is resting on a flat surface, but care is necessary to avoid making the brush too loose a fit in the holder.

The leading and trailing edges of all brushes should be parallel to the commutator segments. To correct any brushes that are not in alignment, shims may be used between

Fig. 5. Sanding brush faces with sandpaper or abrasive cloth

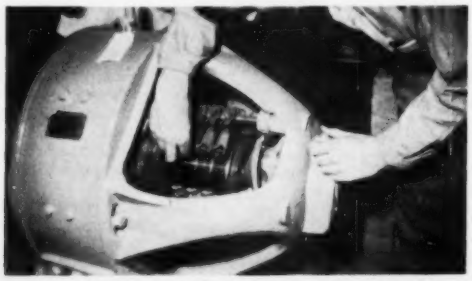


Fig. 6. See that the brush moves freely in the brush holder

Fig. 7. Removing defects in the brush holder box

the brush holder and the supporting stud. It is not advisable to attempt to straighten the stud in the field, because of the danger of loosening it or damaging the insulation between the stud and the end bell. Any serious misalignment of brush holder studs should be corrected in a motor repair shop.

An unusual condition developing in the commutation of a motor that has been running satisfactorily, and which is being maintained properly, is a signal that something is at fault. Severe and continuous sparking may be caused by an open or weak field circuit, or a shift of the brushes from the neutral zone. An intermittent heavy sparking, with one or more burned spots showing on the surface of the commutator is usually caused by an open place in the armature coil circuit. If the sparking is accompanied by chattering of the brushes, it is likely that a high or low commutator bar is responsible for the trouble. Sometimes pronounced sparking of one or more brushes can be traced to insufficient spring pressure on one of them, usually caused by the spring having slipped its setting, broken, or lost its temper. The latter condition is generally the result of a loose brush pigtail connection, either at the brush or the brush holder, which has caused heating of the brush or holder.

While commutation is a problem inherent with d-c motors, it is a problem that can easily be solved, in most cases, merely by seeing to it that every such motor receives its share of regular periodic attention. A few minutes spent in this manner once a week on each motor will insure good motor operation. Of course, a daily cursory inspection, in addition, is even better.

Basic Power Plant FIGURING

A Review for Old-Timers—A Must for Young-Timers

By **WILLIAM H. ENGELMAN**, Mechanical Engineer
Department of Water & Light, City of Cleveland, Ohio

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Some Comments on Fluid Flow

Measurement of the flow of fluids is essential in most phases of power engineering work. Below are presented information and problems concerning the most common and most useful methods of fluid measurement.

The only absolutely accurate way to measure fluid flow is to catch the escaping liquid or gas and weigh it on scales. This is extremely unhandy in a modern plant and the following simple and easy methods are recommended.

Any good text on hydrostatics and hydraulics will explain how liquid flow can be calculated through an orifice. In order to calculate the flow, the area of the orifice, the coefficient of discharge, and the pressure or head on the orifice must be known. Let:

Q = the volume of liquid flowing in cubic feet per second (cfs).
C = the coefficient of discharge.
A = the area of orifice in square feet. (area in sq in. ÷ 144).
h = the head on center of orifice in feet of water or pressure in psi × 2.31, since 1 psi equals 2.31 ft head of water.
g = the acceleration due to gravity (32.16 feet per sec per sec).

$$Q = CA\sqrt{2gh} = CA\sqrt{2} \times 32.16h$$
$$= CA \times 8.02\sqrt{h}$$

One should notice the similarity of the above formula to the hydraulics formula for flow through a frictionless pipe, where:

$$Q = A\sqrt{2gh}$$

The only difference is the addition of the coefficient of discharge in the orifice formula. What happens can easily be seen in Fig. 1.

When water flows through a sharp-edged orifice, the jet contracts a short distance after it issues from the orifice. This contraction is called the "vena contracta." It has been proved by experiments that the area of the vena contracta is about 62 per cent of the area of the orifice. Thus only 62 per cent as much water issues from the orifice as would flow in a frictionless pipe of the same diameter as the orifice.

Values of C

Because of turbulence in the water (fluid friction) the velocity in the vena contracta is approximately 99 per cent of the calculated theoretical velocity in a frictionless pipe. Since the area and velocity in the vena contracta are the limits placed on the flow of the liquid through the orifice, the product of the two factors, C, is used in the formula for the discharge and is 0.62 × 0.99 or about 0.60 to 0.61.

From this it is seen that the accurary of the orifice as a metering device is as accurate as is the values of the coefficient of discharge. This value is dependent on several factors:

1. Head; 2. Temperature of liquid; 3. Viscosity; 4. Size of orifice.

Where extreme accuracy is not required the value of 0.60 to 0.61 for C will give the answer with a very small error.

Example: Calculate the volume of water discharged through a ½-in. diameter orifice under a head of 144 ft.

A = 0.5 × 0.5 × 0.7854 ÷ 144 = 0.0013635 sq ft
C = 0.61
h = 144

$$Q = 0.61 \times 0.0013635 \times \sqrt{2} \times 32.16 \times 144$$

but the square root of 2 × 32.16 is 8.02 (a constant) and the square root of 144 is 12

Q = 0.61 × 0.0013635 × 8.02 × 12 = 0.08005 cu ft per sec and 0.08005 × 60 × 7.48 = 35.9 gpm.

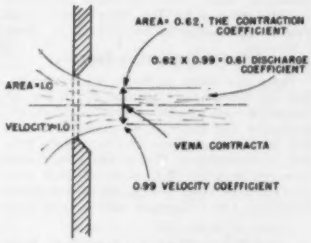


Fig. 1. Action of fluid flowing through sharp-edged (thin plate) orifice

Example: The demand through a 1.5-in. diameter sharp-edged orifice in a 3 in., Sched. 40 pipe is 250 gpm. What is the pressure in psi required to produce the flow?

Converting time, volume, and pressure to the original formula:

Q = 250 ÷ (7.48 × 60) = 0.557 cfs.

A = 1.5 × 1.5 × 0.7854 ÷ 144 = 0.01227 sq ft.

(A = 0.012271185 sq ft, from table)

$\sqrt{2gh} = 8.02\sqrt{h}$ or $8.02\sqrt{2.31p}$; where p = psi

Then $0.557 = 0.61 \times 0.01227 \times 8.02 \times \sqrt{2.31p}$

and $\sqrt{2.31p} = \dfrac{0.557}{0.61 \times 0.01227 \times 8.02}$

$= \dfrac{0.557}{0.06001} = 9.279$

$2.31p = 9.279^2 = 86.10$

$p = 86.10 \div 2.31 = 37.3$ psi required.

It must be remembered that we are concerned here only with the most elementary ideas of fluid flow and not at all with the necessary refinements involving Reynolds number, compressible fluids, d/D ratio, pressure correction factors and so on. For a complete detailed study of fluid flow and its measurement, the authoritative publications for the power engineer are those of the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

THE PRACTICAL ENGINEER AND ELECTRICIAN

These include:

Fluid Meters, Their Theory and Application —Part I ..... Price $3.25
Fluid Meters, Selection and Installation—Part III ..... price $1.75
Flow Measurement (1949) ..... price $2.75
Orifice Coefficients (Recommendation of Joint AGA-ASME Committee) ..... price $2.75

For the most practical data on selecting, installing, piping and checking the accuracy of a flow meter installation, get a copy of Flow Metering, price $1.00, from The Hays Corp., Michigan City, Ind., or from W. C. Bennett, president, Penn Industrial Instrument Corp., 3116 N. 17th Street, Philadelphia, Pa. The material contained in this book was prepared by Mr. Bennett and much of it was published in a series of articles in 1942 in *Power Plant Engineering*, now POWER ENGINEERING. Other related articles were later published in other magazines in the field. These were all collected and published as a booklet, first by Cochrane Corp., then rewritten, expanded and republished by The Hays Corp. It is now being revised to bring it up to date.

Other Information Sources

There are many textbooks on hydraulics, also on flow meters themselves, giving all the latest data on their design, construction, operation and the theories underlying them. For the power engineer who must make himself an authority on flow meters these books must be studied. But much of what they contain is of value principally to instrument designers and instrument maintenance men.

A few of these are:

Fluid Flow in Piping by J. M. Dalla Valle, Heating & Ventilating, 148 Lafayette St., New York 13, N. Y.

Fluid Flow in Pipes by Clifford H. McClain, 21 W. Wilmot Ave., Havertown, Pa.

Differential Fluid Meter Handbook by E. Curtis Richards, Brown Instrument Co., 4491 Wayne Ave., Philadelphia 14, Pa.

Flow of Fluids, Technical Paper No. 409, Crane Co., 836 S. Michigan Ave., Chicago, Ill.

Flow Measurement with Orifice Meters by Stearns, Johnson, Jackson, Larson, D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.

Principles and Practice of Flowmeter Engineering by L. K. Spink, The Foxboro Co., Foxboro, Mass.

The power engineer can obtain valuable help from the publications of the various manufacturers of flow meters and should keep in touch with them for their latest catalogs.

Several other devices are used to measure fluid flow in the same manner as the sharp-edged orifice. These, with their average coefficients of discharge, are:

Rounded-approach orifice	0.97
Short pipe	0.82
Re-entrant short pipe	0.72
Venturi tube	0.97

These same devices can be used to measure gaseous flows, but their calibration is much more complex than for liquid flows. If it should become necessary to measure air flow in pipes, reference is made to Kent's Mechanical Engineers Handbook (Power volume).

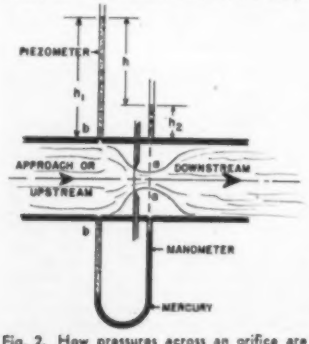


Fig. 2. How pressures across an orifice are measured

Consider an orifice in a pipe as in Fig. 2. Since the same quantity of fluid must be flowing at section a-a as is passing station b-b, the velocity at a-a is greater than the velocity at b-b, but since the velocity at a-a is greater the pressure must be less. A manometer placed as shown in Fig. 2 will show the amount of pressure drop at station a-a, which is proportional to the square of the rate of fluid flow. Then the differential pressure reading obtained from the manometer is an indication of the fluid velocity. Thus a plot of fluid flow versus pressure differential can be obtained for any given installation.

A table of discharge coefficients C_s for circular sharp-edged orifices in vertical position can be found in any textbook on hydraulics. The accompanying table shows that the coefficients are different for size as well as for different heads. See special notes.

Practical Flow Meters

Usually a calibration curve for an installation is obtained from the manufacturer. The flow meter is purchased for a given size pipe and for measuring a given flow range. Then for correct usage of the flow meter, the manufacturer can supply the necessary curves for relating the pressure differential into fluid flow.

In the more elaborate flow meter installations, the pressure differential reading is transmitted either mechanically or electrically to a recording mechanism. The recording mechanism makes an ink tracing on a chart to indicate the manometer level at all times. The chart used in the recording mechanism is printed so as to read flow rates directly; the chart may be circular or rectangular. Also most of these recorders have integrating devices, which allow total fluid flow readings to be taken at intervals. These integrators are usually of an escapement type. (Some are watt-hour meter type). The total fluid flow is indicated on a counter much the same as the mileage indicator used in automobiles. The integrator mechanism is usually set to drive the counter continually at maximum fluid flow and a correct portion of the time at partial flow.

To use the recording types of flow meters most effectively, the manufacturer's instructions and calibrations should be followed. A mathematical calibration of the flow meter could be attempted, but due to the lengthy calculations and the numerous assumptions necessary the accuracy would be questionable. Instead, the manufacturer can test the flow meter experimentally and issue accurate calibration curves with the flow meter.

Referring to Fig. 3, the pressure due to liquid B above line X' — X'' is the same on both sides the manometer.
The pressure due to liquid A below line Y' — Y'' is the same on both sides of the manometer.
Let s be the specific gravity of liquid B
s' be the specific gravity of liquid A
Then: pressure due to liquid B is equal s h
pressure due to liquid A is equal s' h
The pressure differential is equal to the difference of the two pressures:

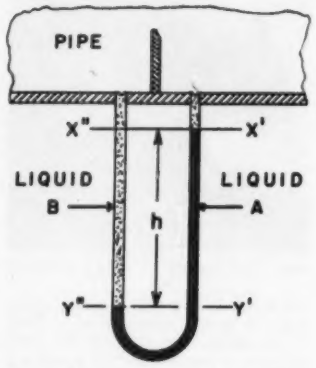


Fig. 3. Relation of liquid and mercury pressures in manometer measuring pressure differential across an orifice

$$p = h\,s' - h\,s = h(s' - s)$$

Let Liquid A = mercury, then s' is 13.56
Liquid B = water, then s is 1.0
therefore: $p = h(13.56 - 1) = 12.56\ h$.
Very important when mercury under water. if h is in inches then p = inches of water.

Practical Application of the Table for Circular Openings

Whenever many decimals are involved in multiplications and divisions for areas and volumes, they present difficulties, are cumbersome, and very often lead to mistakes. The accompanying table has been calculated to save time and trouble. The volume of fluid flowing through a sharp-edged circular orifice is much easier obtained from the items A, B, and C in Table II which will be shown in a practical application.

ITEM A is the area in square inches and also the volume in cubic inches per linear inch.
ITEM B is the area in square feet and also the volume in cubic feet per linear foot.
ITEM C is the volume per linear foot in gallons, (item B × 7.48052).

Calculate the volume of water discharged per minute through a ½ inch diameter sharp-edged orifice under a head of 144 feet (previously example).

$$Q = C\,A\,v = C\,A\sqrt{2\,g\,h}$$
$$Q = 0.61 \times 0.00136354 \times \sqrt{2 \times 32.16 \times 144}$$
$$Q = 0.61 \times 0.00136354 \times 96.24 = 0.0800485 \text{ cfs}$$
$$Q = 0.0800485 \times 60 = 4.803 \text{ cfm}$$

and 4.803 × 7.48052 = 35.9 gpm
Note: The velocity is 96.24 fps or 5,774.4 fpm.
Theoretical volume is 5,774.4 × 0.00136354 = 7.87363 cfm.
by using the constant C as 0.61, the actual volume is 7.87363 × 0.61 = 4.803 cfm.

For values larger than those given in the table the following application can be made:

If the diameter is double that in table the values under A, B, and C must be multiplied by 4; thus: for a 2.5 in. diameter use values for 1.25 inch diameter and multiply by 4.

Item A × 4 = 1.22718463 × 4 = 4.9087385 sq in.
Item B × 4 = 0.00852212 × 4 = 0.0340865 sq ft.
Item C × 4 = 0.06374985 × 4 = 0.2549994 gal per linear foot.

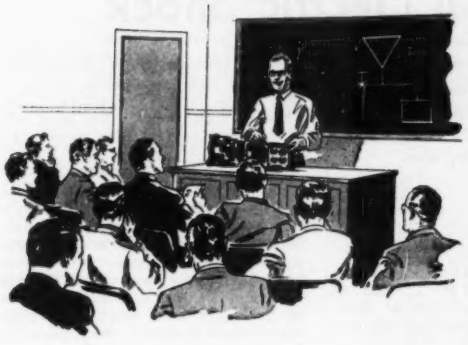
Table I. Discharge Coefficient for Circular Sharp-Edged Orifices in Vertical Position with negligible Velocity of Approach

Head on center of orifice, Ft.	Diameter Inches	¼	½	¾	1.0	2.0	4.0
	Diameter Feet	0.0208	0.0417	0.0625	0.0833	0.1667	0.3333
0.5		0.660	0.634	0.622	0.612	0.603	0.601
1.0		0.640	0.622	0.613	.609	0.602	0.597
2.0		0.630	0.614	0.607	0.604	0.601	0.598
4.0		0.622	0.607	0.604	.602	0.599	0.597
10.0		0.610	0.603	0.600	0.599	0.598	0.597
20.0		0.601	0.599	0.598	0.597	0.596	0.596
50.0		0.596	0.595	0.594	0.594	0.594	0.594

Note: For heads above 50 ft the values for 50 ft should be used. Velocity of Approach is also known as upstream velocity. The values between lines from 0.600 to 0.610 are mostly used in flow circulations.

Table II. Areas of circular openings from 1/64 in. to 2 in. diameter in square inches and square feet

Diameter of Hole			A	B	C
Fract. Inch	Decimal Inches	Milli-meters	Area Sq. Inches	Area Sq. Ft.	Gallons per Linear Ft.
1/64	0.015625	0.3969	0.00019175	0.00000133	0.00000996
1/32	.03125	0.7937	.00076699	.00000533	.00003984
3/64	.046875	1.1906	.00172573	.00001198	.00008965
1/16	.0625	1.5875	.00306796	.00002131	.00015938
5/64	0.078125	1.9844	0.00479369	0.00003329	0.00024902
3/32	.09375	2.3812	.00690291	.00004646	.00034755
7/64	.109375	2.7781	.00939563	.00006525	.00048808
1/8	.125	3.1750	.01227185	.00008522	.00063760
9/64	0.140625	3.5719	0.01553156	0.00010786	0.00080683
5/32	.15625	3.9687	.01917476	.00013316	.00099610
11/64	.171875	4.3656	.02320146	.00016112	.00120527
3/16	.1875	4.7625	.02761165	.00019175	.00143437
13/64	0.203125	5.1594	0.03240534	0.00022504	0.00168340
7/32	.21875	5.5562	.03758253	.00026099	.00195234
15/64	.234375	5.9531	.04314321	.00029961	.00224121
1/4	.250	6.3500	.04908739	.00034089	.00255000
17/64	0.28125	7.1437	0.06212632	0.00043143	0.00322734
9/32	.3125	7.9375	.07669904	.00053263	.00398437
19/64	.34375	8.7312	.09280584	.00064448	.00482108
5/16	.375	9.5250	.11044662	.00076699	.00573749
21/64	0.40625	10.3187	0.12962138	0.00090015	0.00673358
11/32	.4375	11.1125	.15033012	.00104396	.00780936
23/64	.46875	11.9062	.17257284	.00119842	.00896482
1/2	.5000	12.7000	.19634954	.00136354	.01020000
25/64	0.5625	14.2875	0.24850489	0.00172573	0.01290935
9/16	.625	15.8750	.30679616	.00213053	.01593746
11/16	.6875	17.4625	.37122335	.00257794	.01928433
3/4	.750	19.0500	.44178647	.00306796	.02294995
13/16	0.8125	20.6375	0.51848551	0.00360060	0.02693431
7/8	.875	22.2250	.60132047	.00417584	.03123743
15/16	.9375	23.8125	.69029135	.00479369	.03585930
1	1.000	25.4001	.78539816	.00545415	.04080000
1 1/8	1.125	28.5751	0.99481955	0.00690291	0.05163738
1 1/4	1.25	31.7501	1.22718463	.00852212	.06374985
1 3/8	1.375	34.9251	1.48489340	.01031176	.07713732
1 1/2	1.50	38.1001	1.76714587	.01227185	.09179979
1 5/8	1.625	41.2751	2.07394203	0.01440238	0.10773725
1 3/4	1.75	44.4501	2.40528187	.01670335	.12494971
1 7/8	1.875	47.6251	2.76116542	.01917476	.14343717
2	2.00	50.8001	3.14159265	.02181662	.16319962



Emergency Key Design

A FACTORY making women's hats decided to change over its power service from lineshaft drive to electric motors, and chose the Christmas season as the time it could best shut down its factory, just before its samples were due to go out to the trade. The plan decided upon was to use the existing Corliss engine to drive by flat leather belt, a new generator, which would furnish power all over the factory for lights and motors.

There was not room enough in the existing engine room, to set up a good belt drive so a new room was built just outside that room, to house the belt pulleys, the generator, and switchgear. The old standard engine shaft was to be replaced by a longer one, which would reach through the old engine room wall far enough to mount the belt pulley and be supported by the outboard bearing of the engine in its new location in the new room. Then the new belt drive would pass the engine cylinder to the generator, instead of the opposite direction, as it had been. To keep the slack on top of the belt, as is recognized good practice, it was necessary to reverse the direction of rotation of the engine from its previous direction.

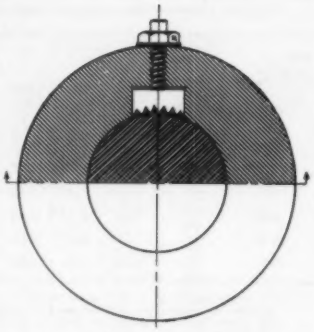
While the opportunity existed, it was decided also to rebore the engine cylinder. So the erecting crew got that job under way at once, as the manufacturer's shop was in the same town, a few miles distant. The ten foot belt pulley on the engine shaft was in one piece, and after dismantling it from the shaft, had to be dragged out of its pit by hand, then around into the new room and be placed in its new pit, next to the new location of the outboard bearing. There, the new extended shaft had to be threaded through it, and then mounted in both bearings of the engine.

The gang was game, knowing the time was all too short, and worked till midnight every night, and for all of the long hours, spared no effort to give satisfaction. The cylinder came back, was placed in position and the valves reset to change direction of rotation—all was ready but the placing of the belt drive for a heavy triplex pump: this had to have a pulley reset, and it turned out, in a spot on its shaft where no keyway existed. This seemed the last straw to the exhausted crew, but the boss got the necessary dimensions together, called the home shop on the phone, and got the new key delivered in good time. It fitted the pulley keyway in the usual style, but there the conventional design disappeared. It was made of good tool steel, and the side next the shaft was curved to the same radius as the surface of the shaft.

But that surface was entirely covered with sharp lengthwise corrugations extending the whole length of the key, looking at the end section much like a sectional view of a coarse bolt thread. These teeth

were well hardened, and when installed in the pulley upon the shaft, and set up to place by the setscrews on the back of the pulley keyway, surely dug into the steel of the shaft in no uncertain manner, especially when coaxed to do so by the persistent blows on the setscrew heads by a heavy hand hammer. The drive for this 25 hp pump was controlled by a heavy clutch, and when testing time came, this clutch was thrown in much harder than was necessary, by way of a destructive test and the key stood the punishment all right, without any show of slippage. After running under full load for several hours, the tightness of the setscrews was again made sure and thereafter that detail was forgotten.

Of course there are ways to cut new keyways in place, but sometimes the tools for the job are not accessible. I have known men to cut a keyway by hand with a cape chisel, filing the job to a fit by hand, but old timers of this rugged character have long since disappeared. How much easier the job could have been done by the above method, granted there was not time to take the job to a shop, or get a portable miller on the work! Certainly this exhausted crew of men appreciated the method as it gave them a chance to get the job finished, and get to much needed rest.



Section of pulley hub, key, and pump shaft

Deaths From Accidental Electric Shock

Analysis of more than 200 deaths due to accidental electrocution by the Metropolitan Life Insurance Co. discloses interesting facts. Electric linemen made up the greatest number of victims. Studies in Switzerland indicate large amounts of myoglobin in kidneys of victims killed by electrocution

By DR. W. SCHWEISHEIMER

THE DEATH rate from accidental electrocution during the last few years was about 7 per million of population. There was no percentual increase despite the fact that the amount of current produced today is about three times what it was twenty years ago.

A study of more than 200 electric deaths in the years 1946-1948 carried out by the Metropolitan Life Insurance Company showed some unexpected facts. For instance, it is not clear why nearly half of the deaths from accidental electric shock occurred in the three summer months. Greater outdoor industrial activity and frequent perspiration in the warm months were no doubt contributing factors, but they do not explain this seasonal frequency sufficiently.

Influence of Occupation

Deaths from electricity are concentrated among adult males and most of them are sustained in the course of employment. Nearly three quarters of the 203 deaths were occupational in nature. Electrical linemen accounted for the largest number of deaths, 42 in all. This was to be expected since the accidental death rate for electric light and power linemen is the highest percentage of all accidental deaths: 374 per cent, when compared with the average figure of 100 among all occupied males between 15 and 64 years. Almost three-fifths of these fatalities were caused by electric shock.

Operatives and maintenance men in electric light and power plants and in other electric industries accounted for 19 more deaths in the statistics of the Metropolitan Life. Nearly as many deaths occurred among crane and hoist operators and helpers. Most of these men were electrocuted when the crane boom or cable struck a high tension wire, and some while repairing or testing the motor or other equipment.

Other electric deaths were caused when pipes or long metal objects carried by workers came in contact with live wires; by short-circuited portable electric drills or other defective machinery. Some men were killed when they struck high tension wires while riding on top of trucks or box cars.

Electrocutions in the home comprise only a small part of the total: 34 out of the 203 deaths in this study. Eight of these were ascribed to defective extension cords, which are particularly hazardous in damp areas, such as yards and cellars. Contact with defective home appliances or their connecting cords was the cause of deaths in 16 cases. The appliances included electric heaters, vacuum cleaners, floor lamps and radios, as well as a clock, a fan, a light socket, and a shortwave radio.

Six persons were in the bath tub when killed, two of them were children.

Deaths from electricity in the home obviously arise out of a variety of circumstances, the study of the Metropolitan Life points out, but most of these fatalities have one element in common—they result from low-voltage current. The fact that low voltages can kill needs to be given additional emphasis so that everyone will know that there is danger in using defective house wiring, connection cords, and appliances.

Outdoor sports accounted for 13 of the deaths from accidental electrocution in the list. Five of the dead were boys and men flying kites or balloons which became entangled in high tension wires, bringing a fatal charge to the victim. An equal number came into fatal contact with power lines while playing on top of box cars or climbing light poles. Three died as the result of touching electric wires while swimming. Wires knocked down by storms took several lives when the victims stepped on the fallen lines or tried to remove them. One person whose car had knocked down a light pole was killed when he attempted to push the car which a fallen wire had energized.

Electric Injuries are Different from Heat Injuries

Stefan Jellinek who has been called "founder of the science of the electric accident" and who has made extensive studies on biological consequences of electric accidents in Vienna, recently has pointed out that the changes produced in the

human body by the electric current are of a special nature. He considers them as "entirely peculiar external injuries," they are different from those caused by heat.

He mentions, for instance, perforations of the tympanic membrane (ear drum), free of pain, with neatly cut edges and without the effect of heat. The same picture appears in great and deep injuries: painlessness, aseptic wounds, no effect on the general condition, slight rise of body temperature. The microscopic examination of the tissues concerned also shows characteristics not seen in other kinds of injuries.

Jellinek points out that the present theoretic knowledge of the pecularities of electric injuries asks for an entirely conservative method of treatment. Two measures which may prove necessary, are: lumbar puncture (tapping of the spine for relief of pressure or for diagnostic reasons) and stanching of sudden bleedings. In this strictly conservative way Dr. Jellinek saw astonishingly good results achieved.

Jellinek's experience seems not to be in the same line as those of F. Jenny who stresses the point that all the changes caused by the electric current are the consequence of heat and who recommends a more active treatment of electric injuries.

High Voltage Accidents

Dr. Jenny's observations were made in Switzerland. In Switzerland too another study appeared recently with detailed observations on accidents caused by high voltage currents. Drs. Hans Fischer and P. H. Rosiver have described four accidents in which men came in contact with conductors carrying 45,000 to 50,000 volts. Two of these accidents were fatal, in two no death occurred.

A man 41 years of age touched a conductor operating at 45,000 volts. After fifteen minutes of artificial respiration he regained consciousness. There were burns but not large ones. Four days later his urine was dark red, and the next day there was complete anuria (inability to excrete urine). Then followed fever, loss of consciousness, death. Autopsy demonstrated electric burns of moderate extent and widespread serious damage of the muscles of the upper arms, the shoulders and the back. From the destroyed muscles a large amount of protein (myoglobin) quickly came into the circulation and caused a functional breakdown of the kidneys.

In a second case the electric injury was similar, extensive burns occurred. In the urine there were large amounts of myoglobin. Death took place four days after the accident. The muscles of the arms showed seriously destroyed parts and bleeding. The myoglobin which came to the fine tubules of the kidneys had stopped the excretion of urine. In two other cases of high voltage accident the clinical picture was similar, but there was no anuria and no death.

It seems, according to Fischer and Rosiver, that in damages due to high voltage accidents the changes within the muscles are more dangerous to life than the burns. Reason is the sudden departure of myoglobin from the muscles which produces the damage of the kidneys. The authors recommend this therapy: alkalization of the urine, immobilization of the damaged extremities, infusion of blood plasma, bloodletting by venesection, infusion of isotonic sodium chloride under the skin, infusion of dextrose. It seems that the departure of myoglobin from the muscles happens only with the heavy current.

EDITORIAL POSITION OPEN

There is a position open on the Editorial Staff of *Power Engineering* for a qualified Assistant Editor. This is an excellent opportunity for a young man with a technical education who has an interest in technical editing and who wishes a permanent position with a 54-year-old organization. We prefer a man between 25 and 35 years old with a Bachelor's degree in mechanical or electrical engineering, one who has had several years of experience in some branch of the power industry. More important than formal academic technical training or degrees, however, are inherent interest in technical editing and evidences of aptitude for it. If you are interested, write to the Editor, *Power Engineering*, 110 South Dearborn Street, Chicago 3, Illinois.

"Johnson," he says, "got a soft ten minute job for you"—Ha!—Ten minutes, he says—Ha!

PRACTICAL HINTS AND KINKS

IMPROVING VENTILATION IN BOILER ROOM

By HOWARD T. LIVINGSTON

HERE ARE two sketches showing one solution to a problem that frequently occurs in a steam plant.

The boiler room walls, on three sides, were of concrete, with no windows or openings. The roof was of concrete, with a monitor, also of concrete. The front and rear walls of the monitor were solid, without openings. The two sides of the monitor were open for the middle three-fourths of their lengths. The theory was that because of the height of the boiler room, it would constitute a natural chimney and the heated air would pass out through the screened openings in the sides of the monitors. To help out, two motor-driven fans were installed in the monitor as shown in the sketch. In hot weather, however, it became uncomfortably hot to work on the two upper walkways.

To correct this condition two ducts were installed, as shown in the sketch, the lower ends terminating in two openings cut in the floor over the forced draft fan room. This room contained two motor driven fans. The fan room was air-tight, and constructed so that air could be drawn in either from the fire room basement or from outside of the building. Since the ducts have been installed, the air has been drawn in from above the boiler.

The new arrangement has greatly reduced the temperature of the air around the walkways. However, under conditions of maximum temperature, another problem developed. The bearings of both the fans and motors are water-cooled, and operated at safe working temperatures, but the fan motors themselves developed excessively high temperatures. This problem was solved by building a sheet metal casing around each fan motor, and supplying it with cooling air by a fan located outside the fan room.

Immediately under the basement floor there is a pipe tunnel for the condenser circulating water pipes. This tunnel is cool even in the hottest weather, so that there is always a supply of cool air for the forced draft fan motors. The cooling fans draw their air from the pipe tunnel.

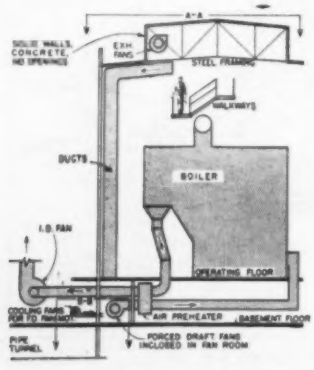


Fig. 1. Section through Boiler Room

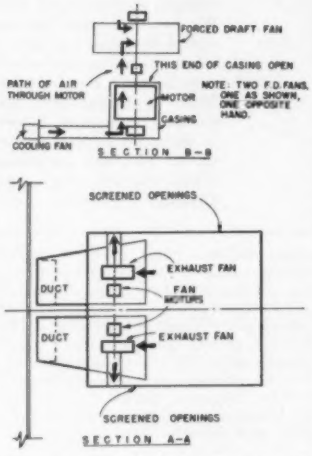
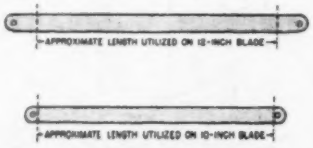


Fig. 2. Details of fan arrangements indicated in Fig. 1

HACKSAW BLADES

USE OF A 10-IN. BLADE, instead of a 12-in. length, in a hacksaw has several advantages. Its cost is less; the

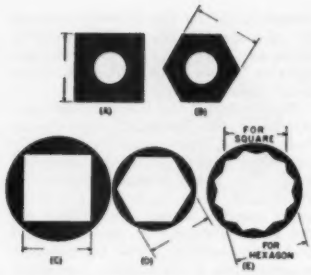


shorter blade and shorter frame length provide greater rigidity; and, as shown, a greater percentage of the cutting edge is utilized.

USING WRENCHES

CONSIDERABLE time can be saved on trips to the tool room or tool storage for wrenches to fit particular sizes of bolts or nuts if the bolt head or nut is measured first to determine the size wrench needed.

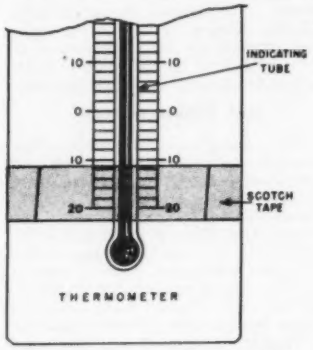
The correct method of measuring



a square bolt head or nut is shown at (a), and a hexagon bolt head or nut at (b). An open end wrench or a square socket wrench is measured as shown at (c), a hexagon box or socket wrench as at (d), and a 12-point box or socket wrench as at (e).

THERMOMETER

SOME TUBULAR type thermometers have no provision for anchoring the indicating tube. This often results in inaccuracy by shifting of the tube. To overcome this, a layer of scotch



tape may be wound around the thermometer and over the surface of the tube, near the bottom, as shown. This will serve to anchor the tube and at the same time permit the indicating liquid to be seen.

LARGEST INDUSTRIAL TURBINE GENERATOR

FOUR-DAY TRIAL run of a new 60,000 kwatt turbo generator—large enough to furnish electric power for a community of 150,000—was completed recently at the South Chicago plant of U. S. Steel company.

The generator is the largest of its kind ever built for industrial power production. It has been under construction since June, 1949.

A newly installed boiler will produce steam for the generator at a maximum rate of 650,000 lb per hr. The boiler is the largest ever designed to operate on blast furnace gas and will consume approximately 140,000 cu ft of gas per minute at full operation.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your questions from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Question No. 482

CAN WE USE OILY EXHAUST STEAM FOR OVERFIRE AIR JETS?

IN OUR PLANT we are planning to install some overfire air jets to produce turbulence in our boiler furnaces and help prevent smoke and flyash emission. We know that most authorities on this subject recommend the use of air jets supplied from fans or blowers, for various reasons, including saving of steam.

However, we have available about 10,000 lb. of steam per 8-hr day, at 10 psi, in the form of exhaust from various small reciprocating steam pumps and a small steam-driven air compressor. We are wondering if this is enough steam and at high enough pressure to be considered for use in the overfire air jets as the propelling medium, instead of using a blower to supply the air.

This exhaust steam contains oil from the pump and compressor cylinders but our figures show that the steam quantity is not sufficient to warrant any elaborate cleaning devices to save it as condensate for boiler feed. Our steam costs us 75 cents per thousand pounds, including fuel, labor, maintenance and fixed charges.

What do Q & A readers think of the idea of using this oily exhaust for our overfire air jets?

Chicago, Ill. R. E. A.

Question No. 483

WHAT'S THE BEST WAY TO DETERMINE AMOUNT OF BOILER BLOW DOWN?

FOR DETERMINING total dissolved solids in our boiler water in our power plant, we use the chloride test, which is very well known and for which standard procedure has been set up. We make this test on the same sample of water on which we run the usual P and MO alkalinity tests.

However, we are well aware that our raw water may not retain the same chloride content and that we can still have quite a wide variation in the actual dissolved solids.

We know that there are other methods for determining amount of boiler blow down as follows:

1. Hydrometer measurement;
2. Evaporation and actual weighing of solids;
3. Conductance measurements.

Do any of these have any advantages that the chloride tests do not have?

Is it possible to say that there is any best method of testing for TDS or does it depend on the operating man's preference, the conditions of the individual plant, the characteristics of the water and a lot of other things like that.

It would be mighty interesting to see comments from Q & A readers telling what method they use and why they prefer it to the others. Then maybe the Q & A editor could tabulate them in some way and see if there is any preferred method.

Indiana S. E. R.

Question No. 484

WILL MIXING SAWDUST WITH COAL IN BUNKER INCREASE FIRE DANGER?

OUR STEAM GENERATING plant is equipped with three 60,000-lb-per-hr Type A boilers, fired by spreader-type continuous-ash-discharge stokers. We store our coal in a 400-ton concrete coal bunker which discharges into a weigh larry.

We dispose of our wood waste (approximately ½ car per week) by distributing it over the coal in the concrete bunker or into a 20-ft diameter silo approximately 70 ft high, located outside the boiler plant. This wood waste is sawdust and shavings from our dust collector system in the pattern shop. It improves the handling qualities of the coal and offers no firing problem in the stokers.

Our question is whether or not this wood fuel, when mixed with coal, will increase or decrease the possibility of a fire resulting from spontaneous combustion.

Columbus, Ohio C. E. B.

Question No. 485

HERE'S AN OLDIE—CAN VERTICAL STEAM ENGINE RUN WITHOUT CYLINDER LUBRICATION?

MANY STEAM ENGINES, both hozizontal and vertical, are giving very good service in industrial plants throughout the country. Those of us who are relatively young in the business do not, of course, remember when the steam engine was the predominant prime mover. But in talking with old-time engine operators, I have heard several of them maintain that there have been a number of vertical steam engines operated without cylinder lubrication. Of course, I have never seen anything like this, and nobody seems able to show me such an engine.

It seems to me if this were possible it would permit the use of the vertical engine in a great many industrial plants where it cannot now be used because the exhaust steam is required for process heating and the oil in the steam would deposit in process equipment and piping or, worse, the condensate would retain oil from the equipment, so that it would be dangerous to return it to the boilers. This point was effectively brought out in the article De-oiling Condensate for Boiler Feedwater in the April issue.

However, any process for de-oiling condensate is going to cost you some money and if it were possible to prevent the oil contamination in the first place, saving is obvious.

I'd like very much to have comments from Q & A readers on what they know about this. If it is possible to do it, then why does every vertical steam engine I see have complete cylinder lubrication?

Chicago, Ill. AMBITIOUS AL

"Piccadilly Apts., Combustion Engineer's Office, Mr. Murphy's secretary speakin'."

13th Annual Midwest Power Conference Held at Chicago

STEADILY-INCREASING attendance year after year at the annual meetings of the Midwest Power Conference is one good evidence of the importance of this Conference to the power engineers of the nation. This year the total registration at the Conference was 1720, compared with 1400 in 1950. In addition, many engineers who could attend only one event of the Conference, and were admitted without registration, raised the total attendance to between 2500 and 3000.

The Conference was held April 4, 5 and 6 at the Sherman Hotel in Chicago.

Simultaneously, the Chicago Electrical Industry Show, sponsored by The Electric Association of Chicago, was held at the Hotel Sherman. Over 50 exhibitors displayed electrical switchgear and controls.

Technical highlights of the Conference were: Extensive discussion of problems of water supply and water treatment; details of design and operating experiences at the new Ridgeland Station of Commonwealth Edison Co.; consideration of boiler operating problems such as soot blowing, fireside deposits; design of small power plants and their instrumentation and control; progress reports on gas turbine locomotives and a report of significant progress in development of the coal-burning gas turbine.

Details of Ridgeland

General design of Ridgeland Station (fully described in POWER ENGINEERING, January 1951) was further discussed and amplified by H. C. Schroeder of Sargent & Lundy.

Details of the electrical design and construction at Ridgeland were given by John C. Woods of Commonwealth Edison Co.

Before the initial operation of Ridgeland Station, said R. B. Gutekunst, chief engineer of Ridgeland, the organization of the operating and maintenance forces had to be carefully worked out. Briefly, with the centralized control, various engineers had to have knowledge and experience to supervise and direct all boiler and turbine generator operations as well as electrical switching. This necessitated careful selection of the men and, in addition, an abandonment of the specialized functions of handling either turbines or boilers or electrical equipment. The staff was trained six months before the expected operating date and the effectiveness of the program became apparent when operation began.

Fuels and Boilers

Soot and slag blowers in modern power plants were reviewed by D. E. Hibner, Jr., vice president of Vulcan Soot Blower Div. He explained the fundamental construction of retractable blowers, wall blowers and other types, discussed the comparative advantages and disadvantages of blowing with steam and air.

The trend toward reheat was discussed by H. G. Ebdon, vice president of Combustion Engine-Superheater, Inc. He pointed out that after rather extensive use of reheat in the '20's, development of higher steam temperatures and pressures took much of the interest away from the reheat cycle. That trend, however, has been reversed. Between January 1, 1950 and March 1, 1951, a total of 82 reheat units aggregating 9,690,000 kw were placed on order.

Fuel Firing

Reviewing the operating characteristics of spreader stokers, J. S. Bennett, vice president of American Engineering Co., gave data on specific installations of spreader stokers applied to steam generating units of capacities ranging from about 150,000 lb per hr up to 250,000 lb per hr continuous capacity. He called attention to the advantages of installing spreader stokers crossways of the furnace to increase their ability to fire larger boilers (See PE, April, 1950).

Method for minimizing fireside deposits in stoker fired boilers consists of maintaining at least 16 lb of water vapor per 1000 lb of air fed through the fuel bed. Development of this method of humidifying combustion air in plants of the Detroit Edison Co. was reported by Paul Murphy, Jr., and John D. Piper of that organization.

Basic factors in emission of fly ash and cinders from boiler firing of bituminous coal and general theory of the behavior of the particles in boiler furnaces was discussed by Elmer R. Kaiser of Bituminous Coal Research, Inc.

Boiler Water Technology

First session on this was on water supply and conservation in which the ground water resources of the midwest were described in detail by Frank C. Foley, of the U. S. Department of the Interior, while conservation of water was treated by Raymond C. Kelly, president of the Cooling Tower Institute and manager, Equipment Div., J. C. Pritchard Co.

In 2d session, development of organics for water treatment was explained by J. A. Holmes of National Aluminate Corp.

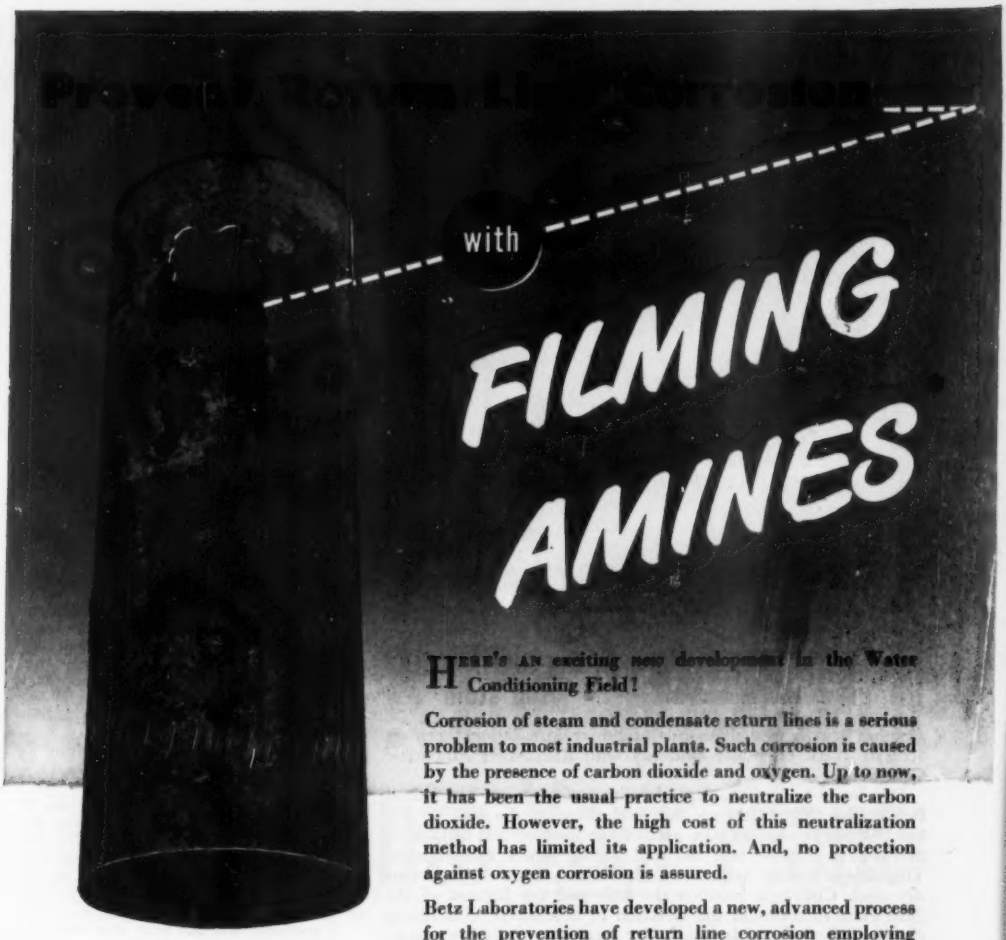
Organic agents in boiler scale and sludge control were discussed in detail by John J. Maguire of W. H. and L. D. Betz. Data on these will be presented later. Organic synergists in foam control were treated by C. M. Bodach and L. O. Gunderson of Dearborn Chemical Co. They described the various organics used in this control, such as certain polyamides and tannins, incorporated with polyamide antifoams, also use of polyalkylene polyglycol type antifoams with various synergists.

Robert W. Liddell and Louis C. Bishop of Hall Laboratories covered use and misuse of organics.

Ion Exchange and Demineralizing

In a third water technology session on ion exchange, S. B. Applebaum of Cochrane Corp. related experience with silica removal demineralizer plants. He first described a silica removal demineralizer at the Prairie Creek Station of Central Iowa Cooperative showing that the results from the demineralizer were so reliable that evaporators previously purchased were not connected.

Details were given of a feedwater demineralizing system for a high pressure, high makeup power and steam producing plant. This was described by J. Harlow of Philadelphia Electric Co., and V. J. Calise and M. Lane of Graver Water Conditioning Co. The plant in question



HERE'S AN exciting new development in the Water Conditioning Field!

Corrosion of steam and condensate return lines is a serious problem to most industrial plants. Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new, advanced process for the prevention of return line corrosion employing *octadecylamine*. This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surfaces in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment. Results? As high as *99 percent reduction* in corrosion rate has been achieved!

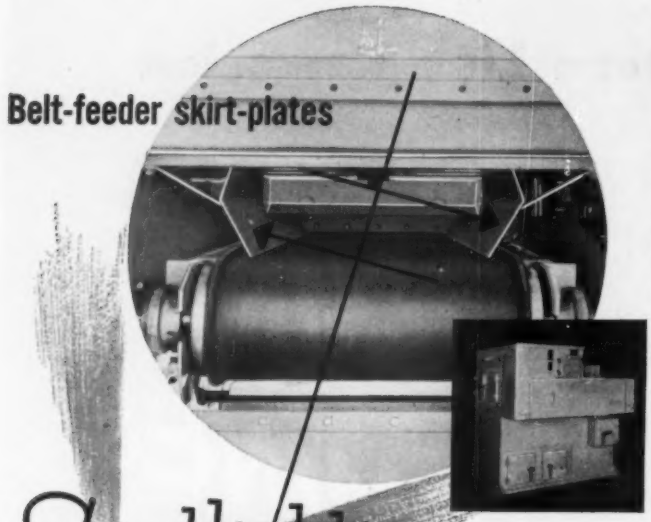
Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation, of course. W. H. & L. D. BETZ, Gillingham & Worth Sts., Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

Send for Betz Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion".

*U. S. PATENT 2,460,299

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT



Spotlighting

DURABILITY in the **RICHARDSON** coal scale

Another reason why thousands of power installations keep an accurate check on boiler efficiency with Richardson Automatic Coal Scales.

Developed to increase dependability and accuracy, Richardson Belt-Feeder Skirt-Plates are designed to guide the coal on the belt. Sloped inward to take part of the load off the belt, these Skirt-Plates increase belt life and reduce power consumption. This design feature maintains full efficiency with either wet or dry coal. Clearance between the belt and the bottom of the Skirt-Plate increases in the direction of belt travel, eliminating the possibility of coal jamming. For maximum protection against corrosion, Richardson Skirt-Plates are made of a high-chrome stainless steel.

Some of the other features that make Richardson Scales the standard of comparison throughout industry are:

QUICK-RELEASE BY-PASS MECHANISM for emergency re-routing coal direct to stoker or pulverizer.

HINGED LEVELING PLATE to establish a uniform "breakaway" of coal each time the feeder belt is stopped, and to allow passage of occasional large lumps without damage to belt.

DIRECT-CONNECTED DISCHARGE COUNTER to register automatically and unerringly the number of discharges.

ALL ELECTRICAL EQUIPMENT mounted outside of corrosive atmosphere of coal chamber.

3 BULLETINS AVAILABLE

Send For Them Today For Complete Information On: EE-39, for dust-tight, average service—200-300 lbs. per discharge—**Bulletin No. 0150.**

Model K-39, for pressure-tight (up to 60" of water), large-capacity service—400-500 lbs. per discharge—**Bulletin No. 0250.**

Monorate, non-segregating coal distributor—**Bulletin No. 1349.**

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

RICHARDSON SCALE COMPANY
Clifton, New Jersey

Atlanta • Boston
Buffalo • Chicago • Cincinnati
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Montreal • Toronto

is the Schuylkill Station of Philadelphia Electric Co. which is being connected to a large district heating system in Philadelphia.

At water technology session No. 4, George H. Krapf of the U. S. Steel Co. described how it was necessary to find some substitute for soda ash in treating feedwater for six boiler plants. It was found that if the Scaife cold-process lime-soda softening plants then used could be converted to zeolite plants, it would reduce the over-all soda ash consumption by approximately 70 per cent.

Gas Turbines

A. G. Mellor of General Electric Co. surveyed the present situation in power generation by gas turbines.

There was much interest in the progress report on the coal burning gas turbines by John I. Yellott, director of research, The Locomotive Development Committee, and it was particularly gratifying that Mr. Yellott was able to report some very fine progress in several stages of the development. Many of the problems are close enough to practicable solution that the future of the coal-burning gas turbine is now virtually assured. The LDC has now operated a full scale Houdry process gas turbine with coal as its primary fuel for 1000 hours. As a result, combustion and ash removal equipment has been constructed, with which a 4200-hp Allis-Chalmers locomotive type turbine will soon be in operation on a stationary test bed at Dunkirk, N. Y.

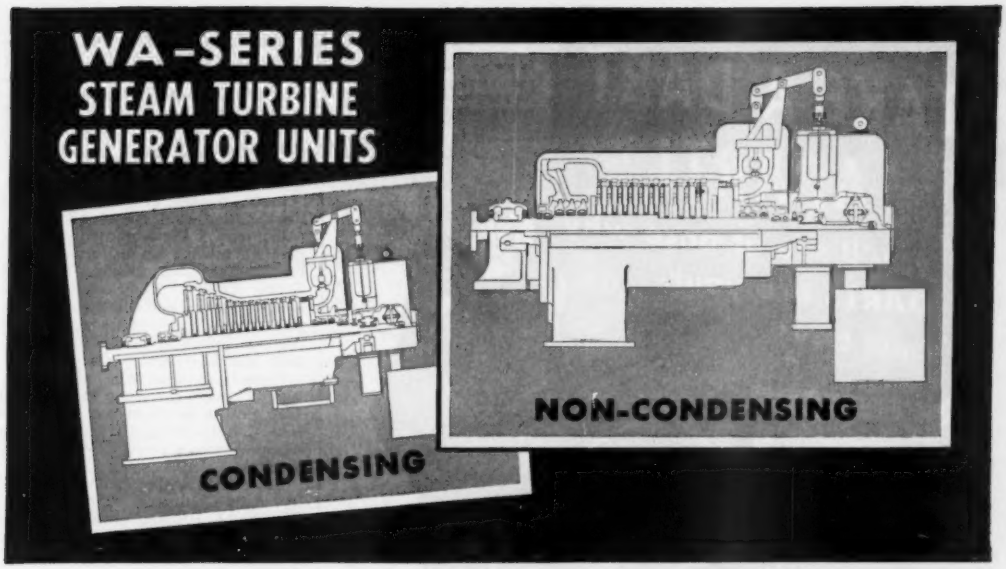
In a subsequent paper, William B. Tucker of Allis-Chalmers Mfg. Co. described an unusual difficulty that arose in testing the Allis-Chalmers locomotive gas turbine unit in the Allis Chalmers' shops at Milwaukee. In operating the turbine a very objectionable organ pipe note was produced. It was finally discovered that the note was being produced in the regenerator. By removal of certain of the tubes, the noise was completely eliminated.

Alan Howard of General Electric Co. reported on the operation of the 4500 hp Alco—GE gas turbine electric locomotive on the Union Pacific Railroad since the summer of 1949. Most of the operation has been on Bunker C fuel. The Union Pacific Railroad has ordered ten more.

T. J. Putz of Westinghouse Electric Corp. reported on the Baldwin-Westinghouse gas turbine electric locomotive. This contains two 2000-hp Westinghouse gas turbine generators. This unit is now in test service on an Eastern railroad.

Small Power Plants

An interesting paper on instrumentation and control for small power plants was presented by P. S. Dickey of Bailey Meter Co. Further details in next issue.



Expanding? The WA-Series will Fit into Your Plant

TODAY INDUSTRY MUST EXPAND while producing at a record rate. To help this vital expansion, Allis-Chalmers offers modern WA-Series steam turbine generator units for industrial and utility steam power plants.

If you prefer high quality construction and modern design, be sure to investigate the recently announced WA-Series, now being built in ratings through 7500 kw. The most recent developments are embodied in this modern impulse design, built for both condensing and non-condensing service, with or without automatic extraction.

Built in NEMA ratings, the WA-Series steam turbine generators are compact, three-bearing, solidly coupled units. They are being built in the condensing type, for power generation only, and in the non-condensing and automatic extraction types, to tie in thermodynamically and provide a steam-power balance where process steam is used.

Design and construction of WA-Series units meet the rigid standards Allis-Chalmers has established for its entire steam turbine line. Just as in the larger steam turbines ranging to 150,000 kw, labyrinth steam seals are used for shaft glands and interstage packing. Corrosion and erosion resistant high chrome alloy steel buckets and nozzles are used throughout in the WA-Series.

WA-Series units are completely coordinated in design. Impulse turbine, housing type air-cooled generator, and exciter are all especially engineered to operate as a unit. *And,* the entire unit is manufactured, assembled, and tested under one supervision at one plant.

Make sure that your next generating unit is *quality* built and has *all* the latest features. Call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3312

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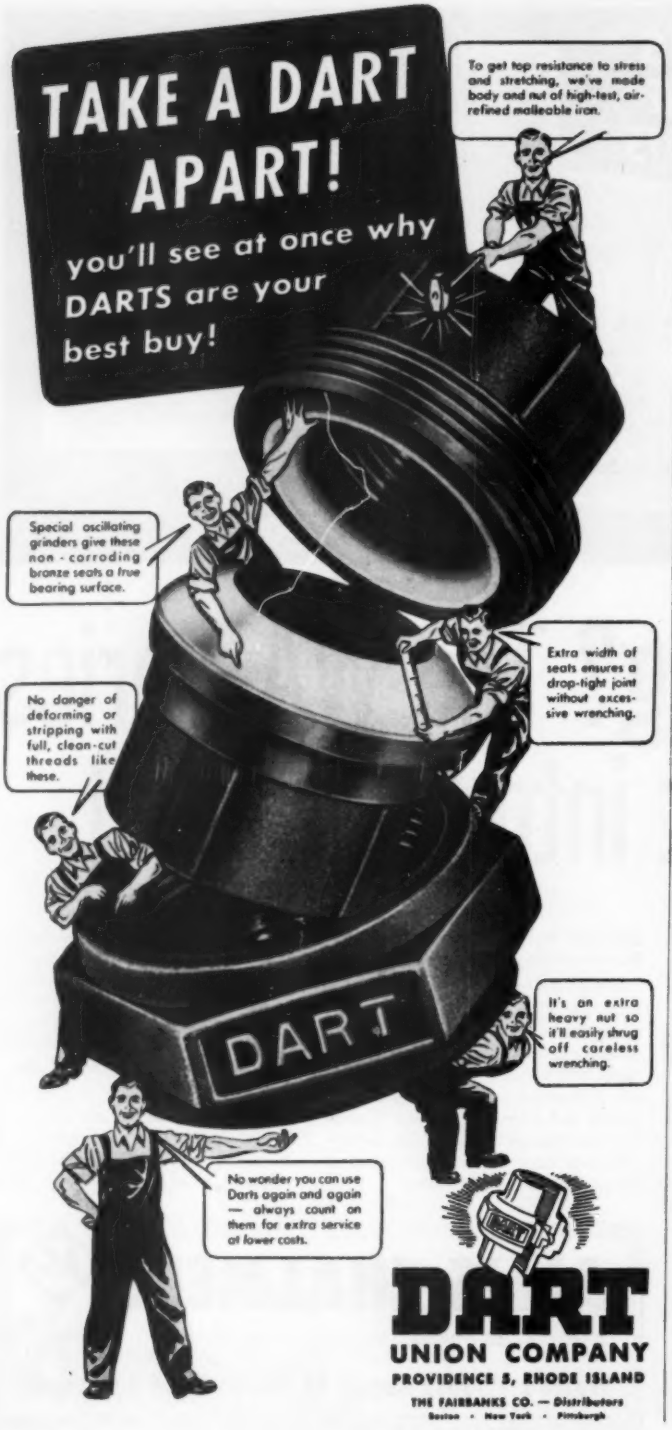
TURBINES & GENERATORS | CONDENSERS & PUMPS | SWITCHGEAR & BREAKERS | MOTORS & CONTROL | TRANSFORMERS | WATER CONDITIONING

World's Widest Range of Power Plant Equipment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you'll see at once why DARTS are your best buy!
To get top resistance to stress and stretching, we've made body and nut of high-test, air-refined malleable iron.
Special oscillating grinders give these non-corroding bronze seats a true bearing surface.
Extra width of seats ensures a drop-tight joint without excessive wrenching.
No danger of deforming or stripping with full, clean-cut threads like these.
It's an extra heavy nut so it'll easily shrug off careless wrenching.
No wonder you can use Darts again and again — always count on them for extra service at lower costs.
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Hydroelectric Problems

Describing the hydroelectric program of the TVA, which has been a controversial issue for many years, Harry Wiersema of Tennessee Valley Authority, Assistant to the Chief Engineer, explained how the 37 water control projects are divided into storage type and run-of-river types and how they are operated.

I. A. Winter of the Bureau of Reclamation said the trend in development of the Bureau's pumping plants is toward the maximum feasible size of unit, such as those at Grand Coulee. However, an even greater requirement is the distribution of smaller flows throughout irrigation developments. Further details will be given.

Recent development of a new type of reversible pump turbine unit (see POWER ENGINEERING, July 1950 issue) has stimulated interest in pumped storage developments in this country.

This machine has been developed by Allis-Chalmers Mfg. Co. and William J. Rheingans, Frank Jaski and Herman Roth of that company gave an interesting paper on its details.

General Features

Among the more general features of the conference were the discussions on engineering education and the impending shortage of technical graduates by President Heald of Illinois Institute of Technology and L. G. Miller, Dean of Engineering at Michigan State College. Both of these educators stressed the importance of more active interest and co-operation by industrial organizations in inducing young men to take engineering courses, even to the extent of paying part of the tuition.

Of great general interest, also, were the three luncheon addresses by John T. Rettaliata, Dean of Engineering, Illinois Institute of Technology; Jack T. Wilson, Chief Physicist, Allis Chalmers; and John Slezak, President of Turner Brass Co. These were delivered on three successive days. Dr. Rettaliata spoke on "Jet Propulsion" discussing its history and development and its present state. As he pointed out, jet propulsion is not new. Hero's turbine, for example, was a device which operated on the jet principle. Jack Wilson, in his talk on what the engineer can contribute to better living, indicated how all through history the engineer had done most toward making life easier. Mr. Slezak discussed the engineering mind in business, showing by example how the application of engineering principles to business problems can save effort and money by avoiding the making of expensive mistakes.

Director of the Conference is R. A. Budenholzer, Professor of Mechanical Engineering at IIT and the Conference Secretary is E. R. Whitehead of IIT.

BIDDLE *Instrument News*

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

NUMBER 5 OF A SERIES

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.

MAKE ELECTRICAL RESISTANCE MEASUREMENTS from a Fraction of an Ohm up to 1000 Megohms

with the BRIDGE-MEG® Insulation and Resistance Tester

Designed to provide maintenance men with a complete multi-purpose instrument, the Bridge-Meg type of Megger® Insulation and Resistance Tester combines the facilities of a Megger Insulation Tester and a Wheatstone Bridge. The Varley Loop feature may be added for locating faults on wires. Here is how it works:

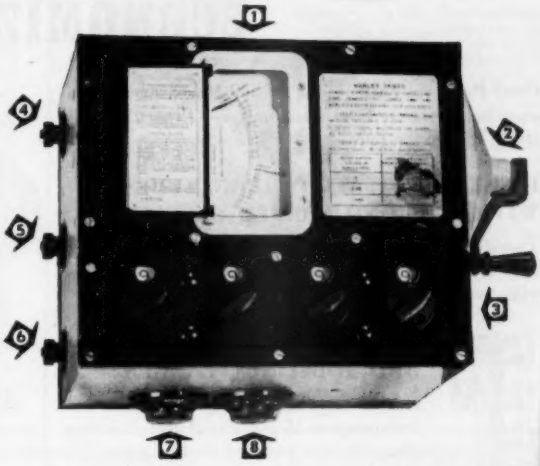
1. Scale—reads directly in ohms and megohms for insulation resistance tests. The pointer "floats" near infinity until the hand generator is operated.

2. Constant-Voltage Hand Generator—supplies direct current at rated voltage (up to 1000) for insulation resistance tests and at about one-third rated voltage for Wheatstone Bridge measurements. Simply turn the crank at about 160 rpm.

3. Wheatstone Bridge Resistances—adjustable dial decade resistance units each reading 0 to 9, giving a total of 9999 ohms for Bridge measurements, or the setting of the ratio switch. Each dial clicks from one position to the next and the figures show plainly through small windows in the top of the instrument.

4 & 5. Testing Terminals—these two terminals are used for both insulation tests and Wheatstone Bridge measurements of conductor resistance, according to the position of the changeover switch.

6. This terminal is included in instruments having the Varley Loop feature and is for the Varley Earth connection when locating faults.



7. Change-Over Switch—a multi-position rotary switch for changing internal connections between insulation resistance tests, Wheatstone Bridge measurements and the Varley Loop connection.

8. Ratio Switch—indicates whether the Wheatstone Bridge resistance dial readings should be: ÷ 100, ÷ 10, × 1, × 10, or × 100.

For more complete information we will mail you Bulletin 21-60-PE.

ARE YOU SURE OF PROTECTION THROUGH YOUR GROUND CONNECTIONS?

Biddle Ground Tester measures low resistance

Photo Courtesy Copperweld Co.

In spite of apparently good lightning rod or arrester protection, lightning frequently will cause severe damage if high ground resistance hampers its dissipation in the earth. The season for lightning storms is returning to the northeastern states. Now is the time for plants in this section to make a thorough round of ground resistance tests. Aside from the hazards to personnel, thousands of dollars may be saved in damage to electrical equipment and in loss of power and stoppage of production.

The MEGGER® Ground Tester is the easiest, quickest and most accurate method of determining ground resistance. It is an instrument specially designed for the purpose and should be used wherever possible. Direct readings are automatically obtained in ohms. It provides its own source of current—no batteries, or other remote source required. It's easy to carry, too. Has approval of the Associated Factory Mutual Insurance Companies.

Don't put it off—write today for "Grounding Electrical Circuits Effectively" by J. R. Eaton (Bulletin 25T-PE) and our Biddle manual on "Ground Resistance Testing" (Bulletin 25J-PE).

HERE'S A "GOOD COMPANIONS" KIT FOR PRACTICAL ELECTRICAL ENGINEERS AND MAINTENANCE MEN

Men concerned with all-around-the-plant electrical tests and resistance measurements tell us that these are "indispensable" tools:

Midget Megger® CVM constant voltage type of Megger® Insulation Tester for detecting dirt, moisture and deterioration in advance of failure, or as a trouble-shooter after failures occur.

The Midget Megger Circuit Testing Ohmmeter for measuring conductor resistance of coils, contacts and relays, and checking continuity of circuit and grounded parts.

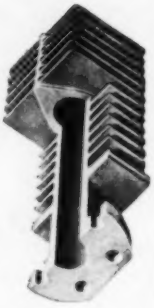
Be sure to write for your copy of 21-85-PE today.

GREEN

PREMIER DIAMOND

ECONOMIZERS

Good Parts are Essential to a Good Machine . . . Let's examine a Green Fuel Economizer—Type 25—and study the major parts.



FINNED CAST ALLOY IRON TUBES WITH DIAMOND SHAPED SECTION

The diamond shape provides less restricted gas flow; easy cleaning and clearview inspection. The fins provide maximum heating surface in given space.

SEPARATE SUPPORTING AND JOINTING FLANGES

Supporting flange is separate from and independent of jointing flange. Jointing flange is not exposed to hot gases. Through bolts rather than studs are used to connect jointing flanges.

CORRECTLY PROPORTIONED, STRONG CONNECTION BENDS

These are designed to provide needed flexibility with strength. Flanges on tubes, bends and manifolds are accurately machined.

Green specially designed Soot Blower assures thorough cleaning.

Green Type 12 Premier Diamond Economizers—the Steel Tube Units—are made up of equally strong and well designed parts. Send for Bulletin No. 169.

THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

NEWS from THE FIELD

INTAKE TUNNEL DESIGN FOR CONDENSER CIRCULATING PUMPS

HIGH SPEED vertical pumps of the propeller and mixed-flow type are well suited for condenser circulating water applications requiring large quantities of water at relatively low heads. They are simple in design, compact, and occupy little floor space. Their high operating speeds result in high motor efficiency and power factor. Due to the location of the pump runner close to the suction bell, and the high water velocities used, the satisfactory performance of these pumps depends upon uniform flow to the suction. Consequently, proper intake tunnel design is of prime importance.

A paper by A. I. Pomonareff, Manager Condenser Engineering, Westinghouse Electric Corp., before the Annual ASME meeting, New York, November 1950, gives the basic requirements for the design of intake tunnels for high specific speed vertical pumps. Structural limitations and other considerations, however, at times prohibit the use of the ideal location and arrangement of the suction tunnel. The use of small scale models of pumps and intake tunnels permits the observation of flow patterns and evaluation of the hydraulic characteristics of the tunnels and their influence on pump performance. Corrective measures, developed through the use of models, are successfully applied to the prototype to eliminate unsatisfactory tunnel characteristics.—ASME Paper No. 50-A-138.

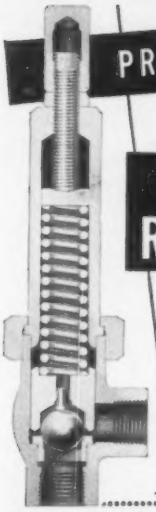
RAISING GROUND WATER TABLE BY RECHARGING

WATER ENGINEERS in Illinois will soon have an opportunity to observe an interesting water conservation project scheduled to get under way in Peoria, Illinois, in the near future.

Briefly, the objective of this project is to restore an average of 1,000,000 gal of water a day through the underyling gravel, in which the ground water table has been dropping for many years. Water from the Illinois River, unusable for direct consumption because of the waste it carries, will be fed into a recharging pit about 50 ft square at the bottom and dug through 35 ft of heavier top soil down to the river valley gravel, about 10 miles long, on which Peoria and its region are located.

Chlorine will be added to the water flowing into the pit. After filtering through a renewable sand bed, the water will spread through the gravel formation, which will filter it as it finds its way to thousands of

Specify these Edward Steel Valves . . . from the Line that Gives You the Better Designs



PROTECT EQUIPMENT

against abnormal pressure increases with

Edward RELIEF VALVES

Edward relief valves protect equipment against sudden and unusual pressure increases in piping systems. Foolproof design and accurate spring action make them absolutely dependable. One low cost valve can save much expensive equipment.

Used extensively in power, chemical, process, petroleum, hydraulic, marine, and general industrial service, they are particularly suited for relieving pressure in pump lines, drums, heat exchangers, and unfired pressure vessels handling water, steam, oil, or vapor.

They need no packing, maintenance is negligible, and the fine pitch threads of the adjusting screw allow close regulation of pressure setting.

NEW BULLETIN Write for new free bulletin No. 711 containing latest design details, dimensions, weights, and installation information.

Edward PRESENTS

New ALL-PURPOSE STEEL VALVES

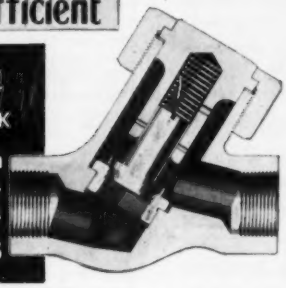
A new all-purpose valve series, ideal for almost any service where small O. S. & Y. steel valves are used. Drop forged steel for greatest strength . . . simplest packing arrangement . . . tight, easily accessible union or bolted bonnet joints . . . bronze yoke bushings . . . microscopically mated seats and disks . . . lock welded parts. Built in sizes ¼ to 2 in. inclusive, globe or angle, screwed or socket welding ends, carbon or chromium molybdenum steels, in 600 or 1500 lb sp classes. Stocks now available.

Bolted bonnet 1-¼ in. up 600 lb, 1 in. up 1500 lb. Union bonnet in smaller sizes.

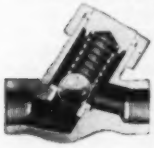
For full details, dimensions, illustrations write today for your free copy of . . . . **BULLETIN 501**

Quiet . . . Efficient

Edward NON-SHOCK Ball & Piston CHECK VALVES



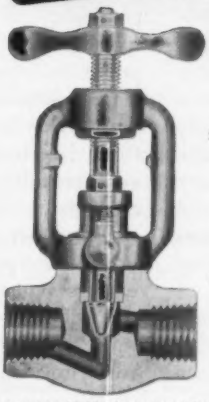
Vibration, clatter, and damaging shock to piping are cut to a minimum with Edward forged steel ball and piston check valves. Cushioned closing action eliminates excessive vibration. Accurate guiding and spring loaded construction assure fast positive seating.



EValloy stainless steel seat and ball or piston give maximum trouble-free service.

Union or bolted bonnet in sizes ¼ in. to 2 in. inclusive in two pressure classes —600 lb at 850 F and 1500 lb at 850 F. For complete information, write for Catalog 104.

PRECISION REGULATION Edward Instrument Valves



New Edward Fig. 952 series instrument valves, so compact they fit limited spaces in such hook-ups as panel boards and manifolds, give precision regulation for meter, gage, regulator, by-pass and instrument lines of all types. Forged steel, globe or angle. Rated 6000 lb WOG, 1500 lb 850 F in carbon steel. Also in stainless steels with higher ratings.

- **No bonnet joint to leak.**
- **Swing bolted gland for easy packing.**
- **Needle point stem, fine pitch threads for accurate regulation.**

WRITE FOR NEW BULLETIN Bulletin 491, with full details, is yours for the asking.

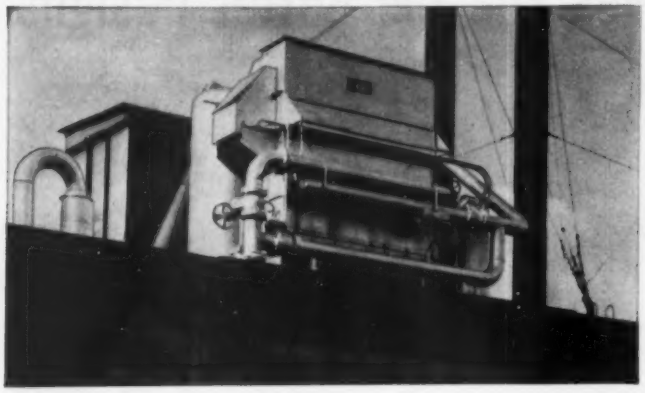
EDWARD BUILDS Globe and Angle Stop Valves • Integral Bonnet Univalves • Gate Valves • Non-Return Valves • Blow-Off Valves • Feed Line Stop-Check Valves • Intex (Integral Seat) Valves • Instrument Valves • Check Valves • Relief Valves • Hydraulic Valves • Gage Valves • Strainers • Special Designs

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO.

EAST CHICAGO, INDIANA

Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

Dept. E, 450 Lexington Ave. **New York 17, N. Y.**

Experienced District Engineers in all Principal Cities

wells supplying water for domestic and manufacturing purposes.

The pit is designed to percolate 2,000,000 gal of river water a day into the earth but it will be operated about only six months each year while the river is cool and relatively clear. More than 85 per cent of Peoria's pumped water is consumed by its industries, which generally want cold water for their processes.

The principal reason the Illinois River cannot replenish its valley sands unaided is that the river bed has become leak-proofed with a lining of impervious silt and sludge many feet thick. During the past 25 years the ground water table of the area has fallen 18 ft despite reductions in industrial use of water.

The recharging pit complete with retaining walls, feed channel and chlorination works will cost about $100,000.

The Peoria recharging experiment holds out promise for other Illinois areas, some with acute water shortages. It might even be possible to recharge the Chicago area of sandstone with water from Lake Michigan when it is clear and cold.

ALLEGHENY COUNTY SUPPORTS BIG AIR CLEAN-UP PROJECT

ALLEGHENY COUNTY, Pennsylvania, became the first municipality to take out a sustaining membership in the Air Pollution and Smoke Prevention Association of America.

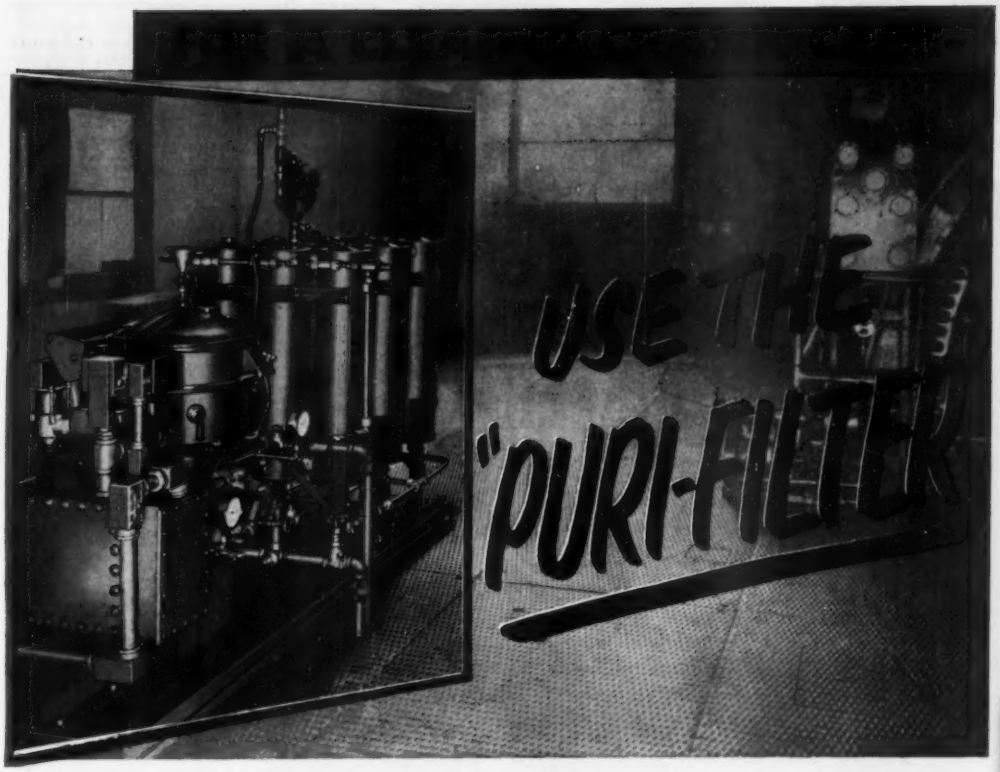
The check was presented by the Board of County Commissioners to Henry F. Hebley, research consultant of the Pittsburgh Consolidation Coal Co., a vice president of the association and chairman of its membership committee.

Hundreds of municipalities are represented in the association, through individual memberships, but this is the first municipal sustaining membership recorded by Mr. Hebley.

* * *

TO MEET anticipated increased demands for service by industry, Public Service Electric and Gas Co. (N. J.) is planning to spend $100,000,000 for additions and improvements to its plants.

The huge capital outlay during 1951 is required to provide additional generating, transmission and distribution facilities throughout the system to meet the demands of increased load. Among the major installations under construction are a 125,000-kw turbine generator at Sewaren Generating Station, which will be placed in operation this Fall; two 145,000-kw turbine generators for operation at Kearny Generating Station in 1952 and 1954, additional 132,000-v transmission lines between Camden Switching Station of Public Service and the Richmond Generating Station of Philadelphia Electric Co. and between the Bergen and Athenia Switching Stations of Public Service.



A clean crank case is a direct reflection of clean lubricating oil. Crank cases of engines whose lubricating oil is purified by a De Laval "Puri-Filter" remain remarkably clean even after long periods.

The answer lies in the dual cleaning ability of the "Puri-Filter." First, the De Laval Oil Purifier removes solid impurities and water by removing them from the oil by centrifugal force. Then the partially purified oil passes through the filters which get rid of colloidal material that is lighter than the oil itself. The result is lubricating oil that is ***visibly*** free of impurities.

The "Puri-Filter" is a compact unit, furnished completely piped up, ready to run, and in capacities to fit every size diesel plant.

THE DE LAVAL SEPARATOR COMPANY
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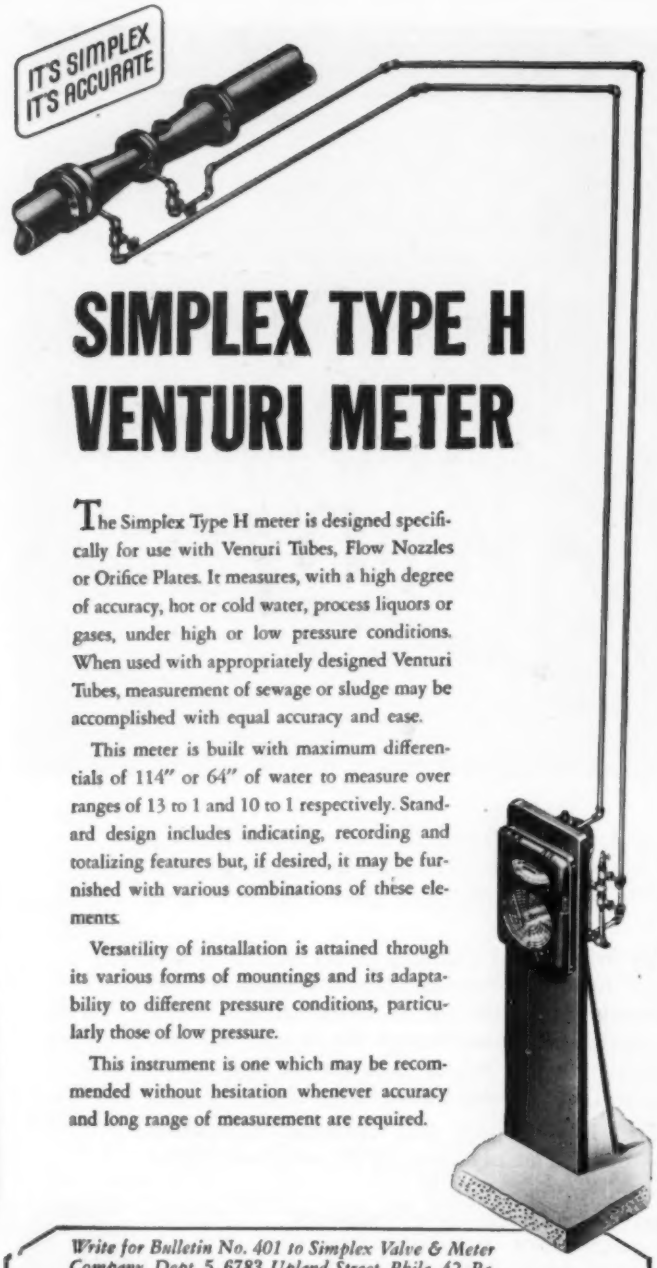
DE LAVAL



SIMPLEX TYPE H VENTURI METER

The Simplex Type H meter is designed specifically for use with Venturi Tubes, Flow Nozzles or Orifice Plates. It measures, with a high degree of accuracy, hot or cold water, process liquors or gases, under high or low pressure conditions. When used with appropriately designed Venturi Tubes, measurement of sewage or sludge may be accomplished with equal accuracy and ease.

This meter is built with maximum differentials of 114" or 64" of water to measure over ranges of 13 to 1 and 10 to 1 respectively. Standard design includes indicating, recording and totalizing features but, if desired, it may be furnished with various combinations of these elements.

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This instrument is one which may be recommended without hesitation whenever accuracy and long range of measurement are required.

Write for Bulletin No. 401 to Simplex Valve & Meter Company, Dept. 5, 6783 Upland Street, Phila. 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

One of the important jobs of the new Southeastern Power Administration of the Department of the Interior will be to see that adequate power is available for the new Atomic Energy Commission's H-bomb plant to be located in southern South Carolina.

New ENGINEERING BOOKS

Plant Layout Planning and Practice by Randolph W. Mallick and Armand T. Gaudreau. First Edition; 391 pages; 6½ by 9¼ in.; illustrated; cloth; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; 1951; price $7.50.

A primary factor in the phenomenal rise in industrial productivity in western countries, particularly in the United States, has been the recognition of the need for specialization in manufacturing operations and complete integration of functions within the framework of each specialized area of action. Basically, the problem involves all the administrative aspects of scientific management, but its specific solution belongs to that division of scientific management which has come to be known as plant layout engineering.

Plant layout engineering as a concept is not new. As indicated by the authors of this splendid book, it dates back as far as 1790 and it has always exercised a dominant influence throughout the development of the factory system. With the first effective appearance of scientific industrial management in 1910, however, layout engineering was engulfed as a branch of industrial engineering along with such innovations as time and motion study, production control, cost accounting, etc.

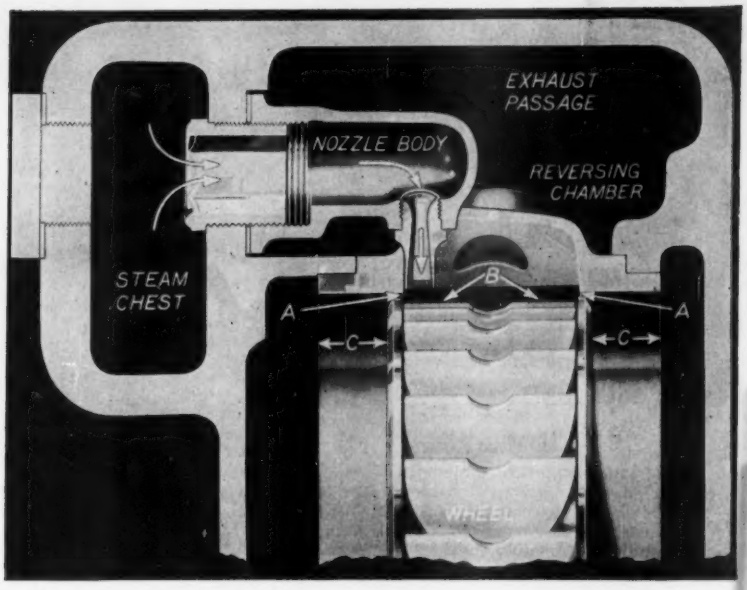
The emergence of plant layout engineering as a conceptual entity resulted from a recognition of the multi-dimensional aspects of time study procedures in its increasing refinement. It was not, however, until the direct electric motor drive emancipated production equipment from the constraint imposed by mechanical power transmission that plant layout engineering attained the significant importance it occupies today in the structure of our industrial culture. At present it is a dominant factor.

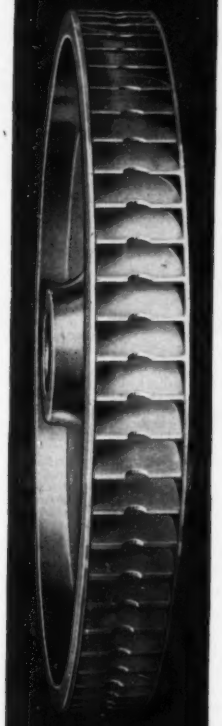
Contrary to the general impression, the importance of plant layout engineering as a dynamic influence in industrial production is not confined to large establishments. Since a large industrial establishment is a series of small plants within the special limits of an economic unit, a plant of 50 workers is as susceptible to improvements by layout engineering as one of 5000 or 25,000.

Plant layout, as shown by the authors, is the master plan that integrates every aspect of the industrial establishment, its grounds, buildings, floors, departments, machine tools, processing equipment, manufacturing methods, material handling equipment, service facilities, flow of production, utilization of labor and shipment of finished products into a unified machine of which management itself is the operator. It is not generally recognized that management can be the designer and builder, as well as the operator, of this complex machine. Plant layout is in effect the blueprint that physically coordinates the 5 different factors in industrial management—men, materials, money, machinery and markets.

It should be obvious that a book dealing effectively with a subject as complex and comprehensive as this could only be written by authors with years of practical experience, as well as theoretical interest, in the subject. And, in the case of this book, these requirements are eminently fulfilled. Randolph W. Mallick, who is at present Executive Staff Engineer of Westinghouse Electric Corp., has an international reputation in the field of plant layout and material handling. He has had 20 years of practical experience in manufacturing operations. Before assuming his present position he had been Assistant to the Director, Headquarters Engineering Staff, and Section Engineer, Plant Layout and Materials Handling Section, Headquarters Staff. Armand T. Gaudreau is Management Consultant with the firm of

TERRY





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Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

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With Prat-Daniel Dust Collectors, an extremely high percentage of the ultra-fine particles are removed from the gas stream. Long, narrow inlets on tubes of small diameter produce high efficiency even at reduced loads. The low velocity reduces erosion and combined with wear-resistant steel construction gives P-D collectors the desired combination of high efficiency and exceptionally long life.

All types of P-D Collectors meet the requirements of most dust ordinances; the high efficiency of the Valmont Type S, however, exceeds the requirements of many of the most stringent ordinances.

"Uni-block" construction, with complete tube sections assembled at the factory, makes relatively low installation costs possible. Hundreds of installations have proved P-D Collectors' all-'round efficiency and low maintenance costs provide a high return on investment. Get the best in dust collectors for your plant. Write our Sales and Project Engineers for Catalog No. 250S.

UNIT RESPONSIBILITY

Prat-Daniel, through its sales and project engineers, The Thermix Corp., offer a complete complement for handling the air gas stream shown at left; 1. Forced Draft Fans, 2. Air Preheaters, 3. Tubular Dust Collectors, 4. Induced Draft Fans and 5. Fan Stacks. This unit responsibility, by a well-known firm, relieves the engineer of the responsibility for one of the most important functions in a steam generating plant.

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Gaudreau, Rimbach and Associates at Pittsburgh, Pa. He has had almost three decades of practical experience with manufacturing operations in enterprises operating chains of various plants in the United States and Canada.

The book is divided into four parts. Part 1 contains six chapters, 111 pages in all, discussing the approach to plant layout. This involves such areas of interest as the role of plant layout in management, ascertaining the need for re-layout, the range of new and re-layout projects, etc.

Part 2 is devoted to planning the processing departments, and comprises six chapters involving 94 pages. This discusses plant layout procedure, analysis and balance and routing of operations, internal transportation, etc.

Part 3, with 7 chapters comprising 108 pages, takes up the design of plant service facilities, receiving, shipping and warehouse areas, test areas, inspection points, dispatch stations, power and lighting systems, office layouts.

Part 4 is entitled, Justifying the Layout Project. This section, consisting of 3 chapters and 108 pages, considers the design of building, capital outlays and methods of presenting the proposal to management.

The chapter on power and lighting systems should be of interest to power engineers, not because of anything it will tell them about power plant design, but because of the relation of the power services to the factory as a whole. This chapter, unfortunately, is somewhat brief but the general discussion is sound. As pointed out, the design of a power house for an industrial plant and also the planning of the electrical power distribution and lighting circuits calls for highly specialized engineering, not within the scope of plant layout engineering. Yet plant layout influences and is influenced by the decision of the power specialist.

The authors are to be complimented upon the excellent bibliography at the end of the book. This lists several hundred pertinent references of considerable value to those interested in this subject. Also, there is a very good index. In short, this is an excellent book.

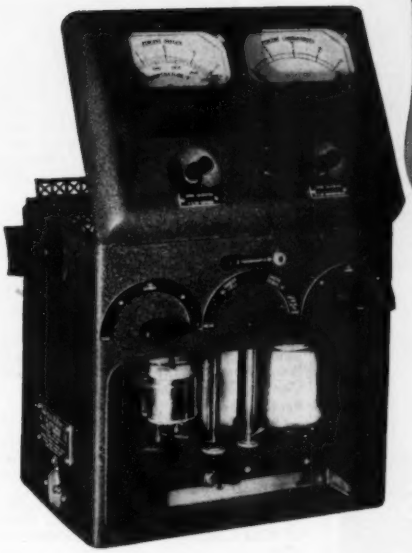
The Kentucky Project. Technical Report No. 13, United States Tennessee Valley Authority. 877 pages, including 307 illustrations, 6¼ by 9¼ in. Cloth. Published by the Tennessee Valley Authority, 1951. Price $3.25.

The Tennessee Valley Authority announces the publication of Technical Report No. 13 on the planning, design, construction, and initial operation of the Kentucky project on the Tennessee River. Besides the importance of the Kentucky project in the over-all system operations and as a point of public interest, its layout, design, and construction involved problems and methods of particular interest to engineers and constructors engaged in similar river-control work. The report contains 877 pages, including 307 illustrations and exhibits.

The report covers in detail preliminary investigations for the project, including geology and river flow; dam and powerhouse design; construction methods, including construction plant, river diversion, employee housing, and access facilities; relocations and adjustments in the reservoir area; initial operations; and a complete summary of the project costs. The appendixes include a complete statistical summary of physical features of the project; reports of the engineering and geologic consultants; summaries of hydraulic studies; a summary of design of Kentucky Dam against earthquake; and lists of classified construction equipment and major purchases of material and equipment. Bibliographies on each phase of the project are also included.

The Kentucky Project may be procured from the Tennessee Valley Authority, Treasurer's Office, Knoxville, Tennessee, for $3.25. Other published reports in this series include: **The Norris Project,** published in 1939; **The Wheeler Project,** 1940; **The Pickwick Landing Project,** 1941; **The Guntersville Project,** 1941; **The Chickamauga Project,** 1942; **The Cherokee Project,** 1946; **The Hiwassee Valley Projects,** Volume 1, 1946; **The Hiwassee Valley Projects,** Volume 2, 1947; **The Douglas Project,** 1948; **The Watts Bar Project,** 1948; **The Watts Bar Steam Plant,** 1948; **The Fort Loudoun Project,** 1949; and **The Fontana Project,** 1949. Except for the Norris, Wheeler, and Pickwick project reports, which are out of print, these reports in limited quantity are currently available from the Tennessee Valley Authority, Treasurer's Office, Knoxville, Tennessee.

I SPY



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This scientific combustion analyzer—the Cities Service Heat Prover—gives you the real "inside" on furnace combustion conditions. Its plain, quick, accurate work lets you know:

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THE SECRET

ROTOJET Motor has only two moving parts, a shaft and a paddle. Positive contact between paddle and Rotocentric (egg-shape) bore cylinder prevents stalling at low speeds. No leakage. Delivers maximum power for air used.

Rotojet owners can expect little or no maintenance problems during the critical times ahead. Simple design has always been a basic feature of Rotojet Motors, which have only two moving parts. That is a very important advantage, especially when quality materials for replacement parts are in short supply.

Replacement parts have always been available for Rotojet Cleaners. During our 40 years of tube cleaner specialization, prompt, efficient service has earned us the good will of our thousands of customers. To help owners of old and new Rotojet equipment to get maximum service, we have prepared a folder showing various accessories which will prolong the life and improve the performance of tube cleaners. We invite you to write for a free copy.

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COMING EVENTS

WISCONSIN POWER CONFERENCE
Program Highlights

Schroeder Hotel, Milwaukee, June 6-7-8

Wednesday, June 6

"The Key to Personal Success"—Speaker, Mr. Philip W. Swain, Editor, *Power*. How to earn more, rise higher and get more fun out of life.

"Evaporating and Burning of Sulfite Liquor"—Speaker, Mr. Nate Malcover, Technical Director, Northern Paper Mills, Green Bay, Wisconsin.

"Mechanical and Electrical Fly Ash Eliminators"—Speaker Mr. Wiley W. Tomes, Cochrane Engr. Corp., Chicago.

"Operating Experience with Fly Ash Eliminators"—symposium.

Thursday, June 7

"Industrial Boiler Plants"—Speaker, Mr. C. E. Miller, Manager, Stoker Dept., Combustion Engineering-Superheater, Inc., New York.

"The Cyclone Furnace"—Speaker, Mr. R. K. Allen, Supervising Staff Engr. of Babcock & Wilcox, New York.

Electric Switchgear, Transformers and Motors for Industrial Plants—Speakers from Westinghouse Electric Corp. and General Electric Co.

Friday, June 8

"The Role Played by Anti-Foams in Preventing Foaming and Improving Steam Quality"—Speaker, Mr. Charles Bodach, Research Chemist, Dearborn Chemical Co., Chicago, Ill.

"Pumps for 1951" — Speaker, Mr. O. M. Kristy, Centrifugal Pump Dept. of Allis Chalmers Mfg. Co., Milwaukee, Wis.

"Power Plant Records"—Speaker, Mr. G. A. Mierendorf, C. E. Engineer, Power Plant of A. O. Smith Corp., Milwaukee, Wis.

OIL AND GAS POWER CONFERENCE

THE TWENTY-THIRD Annual Conference and Exhibit of the Oil and Gas Power Division of ASME will be held in the Baker Hotel, Dallas, Texas, June 25-29.

INSTRUMENT CONFERENCE AND EXHIBIT

THE SIXTH National Instrument Conference and Exhibit will be held in the Sam Houston Coliseum in Houston, Texas, from September 10-14, 1951.

PRIME MOVERS, PEA

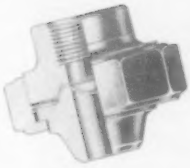
SPRING MEETING of the Prime Movers Committee of the Pennsylvania Electric Association will be held at the Penn-Belle Hotel, Bellefonte, Pennsylvania, on Thursday and Friday, May 24 and 25, 1951.

NATIONAL ELECTRONICS CONFERENCE

THE SEVENTH annual conference will be held October 22, 23, and 24 at the Edgewater Beach hotel in Chicago.

The conference is sponsored by AIEE, IRE, several Midwestern Universities and the Society of Motion Picture and Television Engineers.

Let's take a look at the record!

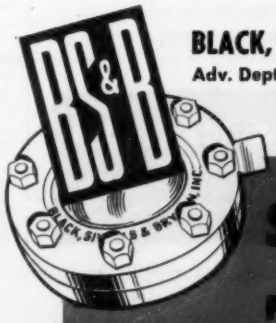


• There is a comprehensive "case history" of each SAFETY HEAD order on file. Should you require replacement discs, a perfect match is assured.

BS&B's records make up quite a library of SAFETY HEAD applications and users. Through the years, their accuracy and completeness save time, eliminate confusion and error.

It's another example of BS&B thoroughness in the exclusive manufacture of these versatile pressure relief devices. No other relief device acts so quickly. The SAFETY HEAD absorbs the shock of overpressure... provides a fully open, pipe-size opening after disc rupture. Eliminates injuries, equipment loss. Avoids costly shut-downs. Tamper-proof, fool-proof SAFETY HEADS *are a must if you have equipment under pressure!*

An analysis of your pressure problem is yours without cost. Write today for details... ask for latest catalog.



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HELP MAINTAIN MAXIMUM PLANT EFFICIENCY..

Hundreds of power plants and refineries have found chlorination by W&T the answer to heat exchanger slime problems. By eliminating slime forming microorganisms, maximum heat transfer is maintained in the condensers. The result — overall plant efficiency is kept at a maximum.

REDUCE LABOR COSTS...

High labor costs involved in frequent condenser tube cleaning are eliminated when chlorination is employed. Manhours used for tube cleaning can be utilized for other maintenance jobs, an important factor with the increasing manpower shortage.

REDUCE DOWN TIME...

Elimination of frequent shut-down for tube cleaning helps power plants stay continuously "on the line." When chlorination is employed, many plants find that outage for cleaning is reduced to once per year and then only for removing trash from tube sheets.

W & T Air Operated Visible Vacuum Chlorinator

Years of operation have proved the dependability and accuracy of W&T Chlorinators for cooling water treatment. Low maintenance and automatic program operation keep operating costs to a minimum. Your W&T Engineer is prepared to make a survey of your plant to recommend the proper chlorination equipment. Write today for more information on slime control — no obligation, of course.

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Obituaries

FRANK A. CHAMBERS

FRANK A. CHAMBERS, 66, deputy in charge of the Chicago smoke inspection office, died March 21 in his home at 7321 South Shore Drive, Chicago, after a brief illness.

Mr. Chambers was a graduate of Armour Institute, now part of the Illinois Institute of Technology. He was financial secretary of the Smoke Prevention Assn. and had been active head of the smoke inspection department for the city of Chicago since 1928.

GUY A. MOFFETT

GUY A. MOFFETT, recently appointed assistant manager of engineering of the General Electric Co. Control Divisions at Schenectady, N. Y., died after a short illness. A G-E employee for nearly 27 years, he was 50 years old.

Mr. Moffett joined the company as a student engineer on the Test Course in 1924, and was transferred to the Control Divisions a year later as a proposition engineer. He was made a line engineer in 1928, and in 1939 became a section engineer.

Following various supervisory positions, he was named engineer of the divisions' Industry Division in 1948. Last July Mr. Moffett was appointed assistant to the manager of engineering for the Control Divisions and held that post until his recent appointment to assistant of engineering for the divisions.

He was a member of the AIEE and the AISE.

J. A. VOLAND

J. A. VOLAND, president of Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., died March 10 at his home in West View, Pa. He had been inactive for the past year and a half. Mr. Voland joined Golden-Anderson in 1913 and assumed the presidency in 1934.

MISSOURI CO-OP

(Continued from page 71)

sure, low gas pressure, and high and low day tank level. There is a kw meter on each engine panel.

All pilot lights, alarms, circuit breakers and emergency lighting are on a d-c system supplied by a 120-v battery set.

Though we have tried to engineer efficiency and safety into the plant, we recognize that good operating personnel is essential to long, successful operations, and have made every effort to assemble a highly competent, experienced staff. E. E. Holwick is South Station Plant En-

Industrial power plant for a large mid-west brewery designed and built by Kuljian

THESE savings are for the man planning more power facilities.

Unified, single contract responsibility effects large savings in engineering and construction of industrial power plants when coupled with the long experience and successful record of the Kuljian organization.

The Kuljian System includes preliminary planning, design, procurement, and construction. Organized to function smoothly and effectively, the Kuljian System saves you time and money.

The Kuljian Corporation is engaged in designing and building power plants for diversified industries and utilities throughout the world. For power that pays, build the Kuljian way under the Kuljian System of *unified engineering and construction responsibility.*

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Gone are the mules and primitive mining methods of 1907. Today, Southern's modern mines bring you a wide selection of carefully prepared coals. Symbolic of these changes are giant haulers which carry coal from open pit to preparation plant.

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Right choice of coal is just as vital to your economical steam production as the application of modern machinery is to your specific production problems.

When coal is precisely fitted to the individual requirements of specific types of burning equipment, it invariably steps up boiler efficiency and substantially reduces your steam costs . . . On-the-job surveys and actual burning tests by Southern's fuel engineers have demonstrated this fact in plant after plant.

Southern ships a wide range of precision-sized, uniform quality, scientifically washed coals—a supply continuously reinforced from Southern's vast reserves. Production is big—in excess of 10,000,000 tons annually.

Lower your steam costs. Investigate this modern fuel service. Write, wire or call your nearest Southern office.

SOUTHERN SERVES YOU FROM AMERICA'S LEADING COAL FIELDS

Industrial buyers choose from a wide variety of premium coals efficiently mined and scientifically processed in the coal fields of Western Kentucky, West Virginia, Virginia, Eastern Kentucky, Illinois, Indiana, Alabama, Arkansas and Oklahoma. *One is right for your equipment.*

A TESTED COAL TO MEET EVERY INDUSTRIAL REQUIREMENT

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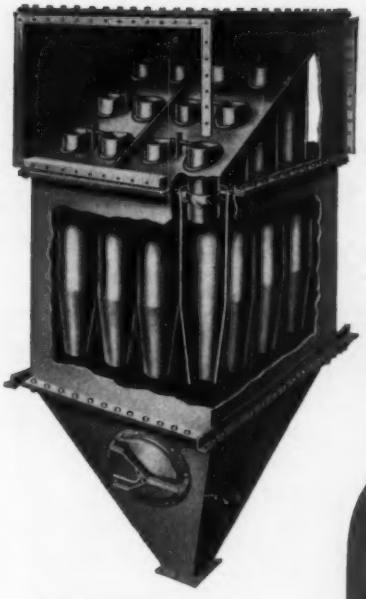
Sinclair Coal Company, Kansas City 6, Mo.—Western Representative
Boon-Strachan Coal Company, Ltd., Montreal—Canadian Representative

gineer. For the entire system, J. E. Shaw is Chief of Operations, H. R. Jackson Construction and Maintenance Engineer, Richard Breckenkamp System Electrical Engineer, Arthur Hunter Central Station Electrical Engineer, W. V. Pendleton Office Manager. The author of this article serves as both General Manager and Chief Engineer.

The large area served by our six REA cooperatives is rapidly-developing dairy country, mostly in the St. Louis milkshed. In the past, the farmers of this area have been discouraged in their use of electric light and power. The power supply was limited and service was poor with voltage dropping as low as 90 v. Today the modern farmer is building an electrified home and also an electrified farm. This combined domestic and business use is raising his consumption to the level of small industrial plants. Our power co-op is endeavoring to provide the dependable, low-cost, abundant power supply necessary to the region's development. In our transmission system, we are building two great loops with dual feed so that, in the event of a break in the line, the break can be isolated and power fed in the reverse direction to the major por-

PRINCIPAL EQUIPMENT LISTING
Northeast Missouri Electric Power Co-op Diesel Plant—South River Station Palmyra, Mo.

Engines: Three 3500-hp, 10-cylinder, 18 by 27-in., 2-cycle, Model 31AD18, dual-fuel engines developing horsepower at 277 rpm. Fairbanks Morse & Co.
Alternators: Three 2480-kw, 3-phase, 60-cycle, 4160-v alternators. Fairbanks Morse & Co.
Lubricating Oil: Rotella and Talpa. Shell Rubilene. Sinclair Refining Co. Ursa X and Ursa P. The Texas Co.
Lubricators: Two Madison-Kipp on each engine. Madison-Kipp Corp.
Lube Oil Filters: United States Hoffman Machinery Corp.
Lube Oil Pumps: Blackmer
Oil Cooler: Ross Heater & Mfg. Co., Inc.
Lube Oil Strainer: Elliott Co.
Well Pumps: Pomona. Fairbanks Morse & Co.
Jacket Water Pumps: Fairbanks Morse & Co.
Water Softeners: Permutit Co.
Fuel Oil Unloading Pump: 100 gpm pump. Viking Pump Co.
Fuel Oil Meters: Bowser, Inc.
Fuel Oil Filters: Cellulose filters. United States Hoffman Machinery Corp.
Governors: Woodward Governor Co.
Intake Air Filters: Continental Air Filter Co.
Silencers: Maxim Silencer Co.
Piston Rings: C. Lee Cook Mfg. Co.
Air Compressors: Gardner-Denver Co.
Switchboard: Westinghouse Electric & Mfg. Co., Inc.
Batteries: Gould-National Batteries, Inc.
Battery Charger: Westinghouse Electric & Mfg. Co., Inc.
Radio Telephone: RCA
Heat Exchangers: Ross Heater & Mfg. Co., Inc.
Gauge Panels: Keith Electric Construction Co.
Pyrometer: Alnor. Illinois Testing Laboratories, Inc.



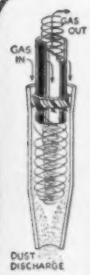
No wonder "MULTICLONE" is the leading name in the centrifugal recovery of dust and fly ash from all types of gases, hot or cold.

No other mechanical recovery equipment has so many years of dust and fly ash recovery experience behind it . . . or has such uniformly high collecting efficiency . . . or provides so many other money-saving, space-saving advantages as MULTICLONE. The four advantages outlined below are by no means the complete MULTICLONE story, but are typical of the vital savings found *exclusively* in MULTICLONE equipment . . .

In dust and fly ash recovery

MULTICLONE COLLECTORS

***and only Multiclones* give vital advantages like these . . .**



Uniformly High Recovery:

MULTICLONE's multiple *small diameter* tubes—made possible by its exclusive vane design—whirl the dirty gases with greater centrifugal force, thus throwing out not only the large, medium and small particles, but also a high percentage of the *extremely small* particles of 10 microns and less. This, coupled with the fact that there are no pads or filters to become choked with recovered material, results in a more complete recovery of *all* suspended materials from the gas stream.

Long and narrow

Square

Maximum Adaptability:

In addition to its unusual compactness, the MULTICLONE is also unusually adaptable to various installation requirements. Where head room is low it can be installed with side-inlet side-outlet connections. Where side clearances are restricted, it can be installed with side-inlet top-outlet connections. In addition, without changing capacities, the shape of the unit can be varied—long and narrow, short and wide, or square—to fit restricted spaces . . . and its single-inlet single-outlet duct requirements permit greater flexibility and simpler installation. These savings slice installation costs, space requirements and insulating expense.

Space-Saving Compactness:

Plant space costs money—so be sure to check space requirements carefully. As shown in the accompanying chart, the MULTICLONE requires less floor space and less cubic space than any other unit of comparable capacity and performance. Translate these savings into today's high costs for plant space and you readily see the great importance of this one MULTICLONE advantage alone!

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.8
Collector B	5.9	3.2
Collector C	6.8	3.9

Minimum Maintenance:

The MULTICLONE has no high speed moving parts to repair or replace . . . no pads or filters to clean or renew . . . nothing to choke the gas flow or increase draft losses as suspended materials are recovered. MULTICLONE draft losses remain uniformly low *at all times.* Further, the recovered material from an entire bank of tubes is collected in a *single* hopper—far easier to service and maintain than the multiple hoppers of conventional cyclone units.

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This 32 page booklet outlines the basic principles of centrifugal dust recovery and shows the *many* ways MULTICLONE advantages assure higher recovery at lower overall costs. A free copy of this booklet will gladly be sent on request. Write today!

Before you decide on *any* recovery equipment be sure to get complete information on MULTICLONE advantages. A letter, wire or phone call to our nearest office places this information in your hands without obligation. Get *all* the facts and you will get MULTICLONE Collectors!

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tion of the system. In our generating system, we have emphasized rugged dependability and operating economy.

It should be emphasized that this is a private enterprise which pays every tax paid by any utility except a profits tax—and we don't pay that because we are a non-profit organization. The six REA cooperatives that own this big power co-op setup are: Missouri Rural Electric Cooperative, Macon Electric Cooperative, Lewis County Rural Electric Cooperative, Ralls County Electric Cooperative, Tri-County Electric Cooperative, and Southern Iowa Electric Cooperative. Officers of this multimillion dollar power system are: R. D. Pennewell, president; Charles D. Miller, vice-president; and F. H. Schmit, secretary-treasurer.

HELPFUL BULLETINS

(Continued from page 36)

blenders and process vessels, kettles, mixers, autoclaves. Patterson-Kelley Co., Inc.

PUMPS, COMPRESSORS

128 Rotary Pumps—Catalog 951, 8 pp. covers a line of rotary pumps for pressures up to 1000 psi, giving sizes, capacities. Explains operating principle of pumps in this line, illustrates construction features of various models. Also shows some examples of custom-built rotary pumps. Geo. D. Roper Corp.

129 Gas-Engine-Driven Compressors — Forty-pp Bulletin 104 introduces the HBA compressors, recent additions to company's "Big Angle" line of gas-engine-driven compressors. These are two-cycle high compression units designed for simplicity, compactness, easy maintenance and more power and efficiency at lower cost. Describes and illustrates 5, 6, 8 and 10 cylinder models of 1100 to 2200 Bhp capacities. Lists major advantages. Sectional drawings show construction and design features. Includes specifications, dimensions. Installation photos show how units fit modern compressor station design. Clark Bros. Co., Inc.

ELECTRICAL

130 Terminals and Connectors—Pressure terminals and connectors for practically all applications on wire sizes from 26 through 250 MCM are listed in Bulletin 61, 40 pp. Gives complete dimensions in simplified tabular form, along with information on Underwriters' Laboratories and Armed Forces approvals. Mechanical drawings and details on installation tools included. Special features are a listing of Armed Forces procurement numbers with corresponding catalog numbers of company's products, and illustrated table of contents. The Thomas & Betts Co.

131 Improved Motor — This 2-pp illustrated bulletin presents a redesigned electric motor. Stresses aluminum frame, completely smooth exterior possible because through bolts have been eliminated, other features. Lists styles available, includes dimensions. Scot, Inc.

COOLING

132 Cooler with Fins—A new oil and water cooler and the several advantages provided by its improved design are described in 20-pp Bulletin 1020. Explains how company's LK-Fin Cooler, distinguished by use of helically-finned heat transfer elements instead of bare tubes, is a lighter, more compact and less costly unit for a given cooling service. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. Also described and illustrated are design details which provide effective heat transfer, permit free expansion of tube bundle, prevent interleakage and leakage to outside, and facilitate maintenance. Includes selection data for various ranges of duties, dimensions, specifications. The Griscom-Russell Co.

133 Double Inlet Cooling Towers—Section 41 describes and illustrates manufacturer's Dry-Fan cooling towers with double-inlet squirrel cage duplex blower, and capacity range of 32 to 60 t of refrigeration. Includes specifications, selection table for air conditioning and related applications, typical temperature performance data, directions for assembling. Binks Mfg. Co.

134 Heat Exchangers — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Cutaway drawing shows how exchanger operates, installation photos show some applications. Niagara Blower Co.

COAL AND ASH HANDLING

135 Efficient Coal Preparation — Facts and features concerning improved coal preparation for power plants are presented in this 8-pp illustrated booklet. Shows how coal is split, not crushed, by rolling ring principle utilized in company's equipment to provide better combustion and reduced ashpit loss through uniform low-cost coal sizing. Tables show relation of sizing of coal to ashpit loss. American Pulverizer Co.

137 For Cleaner Ash Handling—Brochure 251, 20 pp, presents company's Hydrojet systems designed to provide for continuous storage of ashes over long periods of time and their periodic removal in the shortest possible time. Describes briefly how systems are adaptable for continuous slag type, intermittent slag type, V-type dry

RODA

High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

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High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

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High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

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A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

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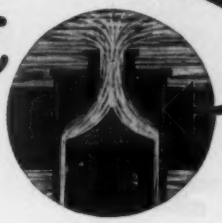
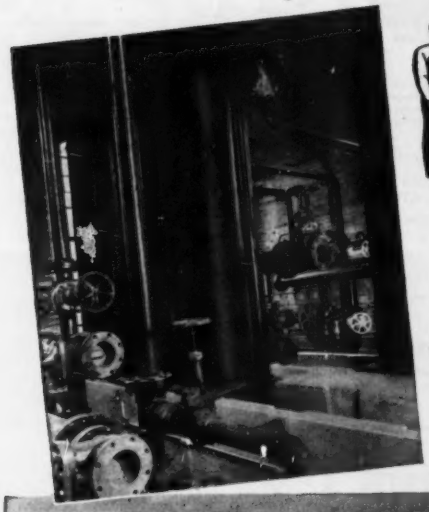
Dirty Water can't "Shut-down"...

Vogt

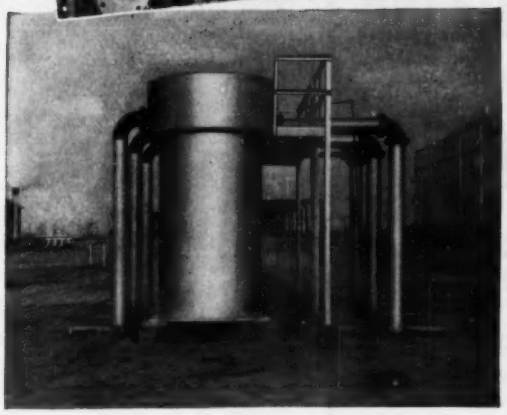




film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

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Paracoil EVAPORATORS

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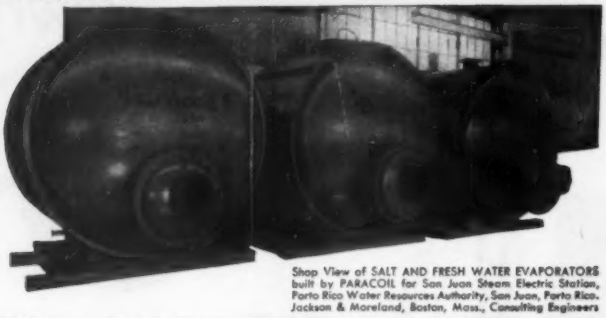

Shop View of SALT AND FRESH WATER EVAPORATORS built by PARACOIL for San Juan Steam Electric Station, Porto Rico Water Resources Authority, San Juan, Porto Rico. Jackson & Moreland, Boston, Mass., Consulting Engineers

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Wherever pure water is needed for boiler feed makeup, process work or general plant operation, a PARACOIL EVAPORATOR is a proven, time-tested means of handling any kind of initial raw water—salt or otherwise.

They are ruggedly built—dependable—and easily maintained. Specific requirements dictate the design. Our years of experience in building units of this type—and other power plant apparatus—assures you of the correct solution to your problem. *We invite your inquiry.*

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in Nicholson Expansion Steam Traps

Remarkably Low Maintenance Costs Shown on Many Varied Installations

There is not a pin, not a bearing, not a link nor a lever to wear in this Nicholson expansion steam trap. The valve is the only moving part. This extreme simplicity is resulting in remarkably low maintenance costs. There are hundreds of instances of traps in continuous service for as much as two years without even a sign of valve cutting.

Appreciable fuel savings are also being effected. Traps are easily adjusted to pass condensate at any temperature below 212° F, instead of at near steam temperature.

Easily installed, often without supports. Lengths, 18" to 40". Pressures, 0 to 250 lbs. No air binding.

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Using Steam or Hot Water

Radiators	Dry Kilns
Separators	Vulcanizers
Paper Machinery	Switch Heaters
Pipe Coils	Laundries
Kettles	Plastic Molding
Railway Coaches	Presses

Catalog 250 or see Sweet's

W. H. NICHOLSON & CO., 160 Oregon St., Wilkes-Barre, Pa.

bottom and stoker fired furnaces, also for replacement installations. Explains construction and operating features, discussing in detail the final disposal of ashes to fill, sump or dehydrating bin. Installation photos included. Allen-Sherman-Hoff Co.

136 Central Station Coal Handling—Twenty-pp Bulletin 103 discusses modern coal handling practices in use in recent central station installations. Describes and illustrates units of equipment—hoppers, feeders, galleries, crushers, weighing and sampling equipment, distributing, separating and elevating equipment, etc. Complete with diagrams, dimensional drawings and many installation photos. The C. O. Bartlett & Snow Co.

TUBING

138 Data on Tubing Steels—Technical Bulletin 19, 4 pp, contains condensed data on analyses, oxidation resistance, thermal treatment, and mechanical, electrical and physical properties of ten most popular austenitic and ferritic stainless tubing steels. The Babcock & Wilcox Tube Co.

139 One-Piece Fintubes—Eight-pp Bulletin 511 describes construction of integral surface fintubes; lists range of sizes and available materials. Illustrates wide variety of heating and cooling applications and gives some extremely helpful engineering data, including design curves and a tabulation of comparative outside surface areas provided by different sizes of bare pipe or tubing, and longitudinally finned pipe or tubing. The Brown Fintube Co.

OTHER EQUIPMENT

141 Anti-Corrosion Coating — Excellent corrosion resistance with cost savings is claimed for Zinclilate, a one-coat, self-protecting, anti-corrosion coating described in 8-pp Bulletin 100. This technical booklet presents case histories on typical applications showing the coating's resistance to severe abrasive and corrosive conditions; gives complete specifications for the two formulations, and includes data on surface preparation and methods of applications. Industrial Metal Protectives, Inc.

142 Push Button Ventilation—Illustrated 6-pp Bulletin 680 gives sizes, dimensions and performance data on power roof ventilators for flat, curved or peak roof installations, having 16 to 60 in. fan diameters and capacities to 78,800 cfm. Gives advantages of ventilation by positive air displacement. Propellair Div., Robbins & Myers, Inc.

143 Oil Burners—Here's a condensed catalog, 16 pp, giving complete listing, with illustrations, of company's oil burner products. Covers fully-automatic horizontal rotary, steam turbine driven, combination gas-oil, semi-automatic and pressure atomizing types. Features a selector chart, also a phantom view of a burner showing fuel patch. Gives specifications, capacities. Booklet should prove especially helpful where additional installation knowledge is required before ordering oil burner equipment. Operation and control of each unit is described. Ray Oil Burner Co.

144 Steam Condensers—Bulletin 102, 24 pp, is a comprehensive presentation of manufacturer's steam condensers and includes photos of six typical installations as well as a section of engineering data, a discussion of air removal equipment, and a chapter on condenser maintenance. Such special equipment as company's Wizard injector to seal small leaks while condenser is in operation, air erosion eliminators, divers lights and port gages, plugs, shock testing apparatus are also described and illustrated. Condenser Service & Engineering Co., Inc.

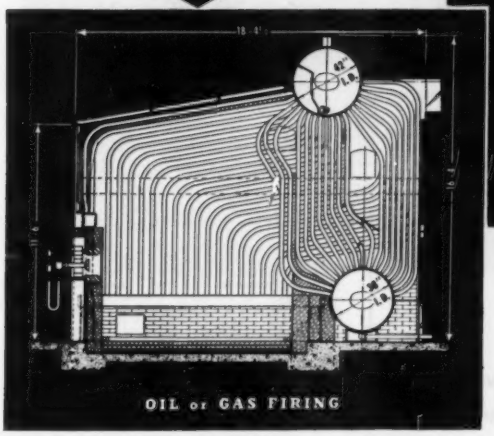
145 Insulating Fire Brick—This 4-pp bulletin presents the economic advantages, industrial applications and refractory properties of an insulating fire brick for sustained use at 3000 F. Physical and thermal characteristics are given in tabular form. An illustrated description shows use of this fire brick in the construction of a slot type forging furnace. Also gives summarized information on accessory materials and other insulating brick. Johns-Manville.

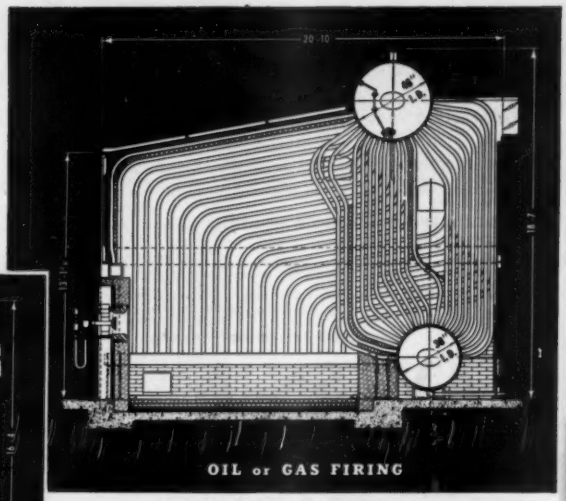
WHICH V-C Meets Your Needs?

Both are High Capacity 2-Drum Water Tube Boiler Units for Limited Space....

3 V-C

This series with 42" top drum—17 tubes deep thru the main boiler bank, has integral water cooling in front, sides and top. A selection of 17 standard sizes available in widths from 5'-2" to 17'-2" and heating surfaces from 1394 to 5426 square feet.





4 V-C

This series with 48" top drum—19 tubes deep thru the main boiler bank—has integral water cooling in front, sides and top. A selection of 17 standard sizes available in overall widths from 5'-2" to 17'-2" and heating surfaces from 1850 to 7245 square feet.

WRITE for Erie City Bulletin SB37A containing complete engineering data for Types 3 V-C and 4 V-C 2-Drum water tube boilers for spreader stoker, underfeed stoker and oil or gas firing. Investigate this steel cased, completely water cooled steam generator which incorporates modern ideas in a compactly designed high efficiency unit.

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Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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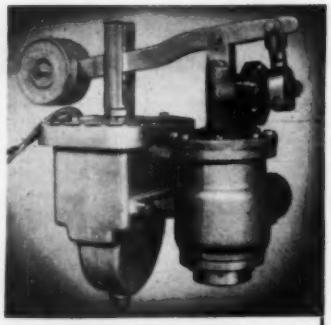

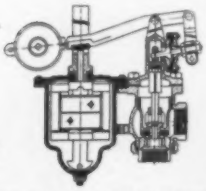

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COMPLETELY SEALED VALVE MECHANISM. Valve stem is connected to solenoid lever through patented "DIA-BALL" packless joint. Widely favored for handling inflammable or toxic gases or liquids.

SELF-CLEANING DESIGN. Can be used successfully for handling heavy, sticky materials because the valve interior is simple, port area large, and outlet downward, thus taking advantage of natural gravity flow. Note that valve seat is accessible for cleaning.

EXPLOSION-PROOF SOLENOID HOUSING. Solenoid coils can be supplied for any current characteristics.

RENEWABLE VALVE DISC. Supplied with composition or metal disc to suit particular requirements. Wide choice of materials available for valve and trim.

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Ask for recommendations.

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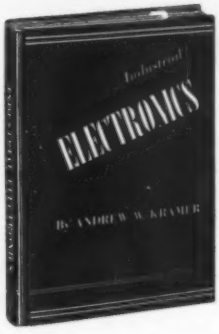

a practical new book about Electron Tubes

. . . what they are

. . . how they work

. . . how they can be used

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146 Revised JIC Hydraulic Standards—The newest edition of the JIC Hydraulic Standards for Industrial Equipment is offered to power engineers in a neat 16-pp booklet, punched for filing. Along with Standards are presented a sample circuit, glossary of terms, standard symbols, information on the various types of piston and rod seals available for different applications. There's also a cutaway illustration showing how company's hydraulic cylinders meet the revised JIC Standards. Miller Motor Co.

147 Bending Manual—"It's Easy to Bend" is a 32-pp booklet filled with information on bending metals. Although numerous illustrations show company's benders, the ideas contained apply to any rotary type bending machine. Besides providing suggestions on the choice of materials and bending machines and discussing tooling it gives illustrated instructions on practically all types of bending. O'Neil-Irwin Mfg. Co.

148 Fire-Resistant Hydraulic Fluids—This 12-pp illustrated booklet on company's hydrolubes presents their physical properties and advantages as well as how to use these fire-resistant fluids, developed to meet the need for hydraulic oils which could be used where fire hazards exist. Their fire-resistance, high viscosity index, low leakage loss and safety factors are described. Carbide and Carbon Chemicals Div., Union Carbide and Carbon Corp.

149 For Sure Footing—This new 4-pp technical bulletin illustrates, describes, and gives application and safe load data on open steel diamond and welded gratings, stair treads and surface armor for old and new floors. Includes information on a flexible floor armor and a reinforcement mesh for ganister linings. Wm. P. Klemp Co.

150 For Tough Pulling Jobs—Illustrated Forms 100 and 101 show how manufacturer's heavy-duty portable hydraulic pulley pullers are built to solve tough pulling problems, reduce damage to equipment and save time and labor. Dimensions, prices, ordering information given for 5, 20 and 50 t capacity models. Industrial Engineering Equipment Co.

151 Electric Vibrators—Semi-noiseless pulsating magnet electric vibrators with variable control are introduced in this 2-pp illustrated bulletin. These have same features as company's standard vibrators; the reduction in operating noise is due to a design change in which rubber bumpers are substituted for metallic striking parts. Specifications included. Syntron Co.

CATALOG LIBRARY

(Continued from page 50)

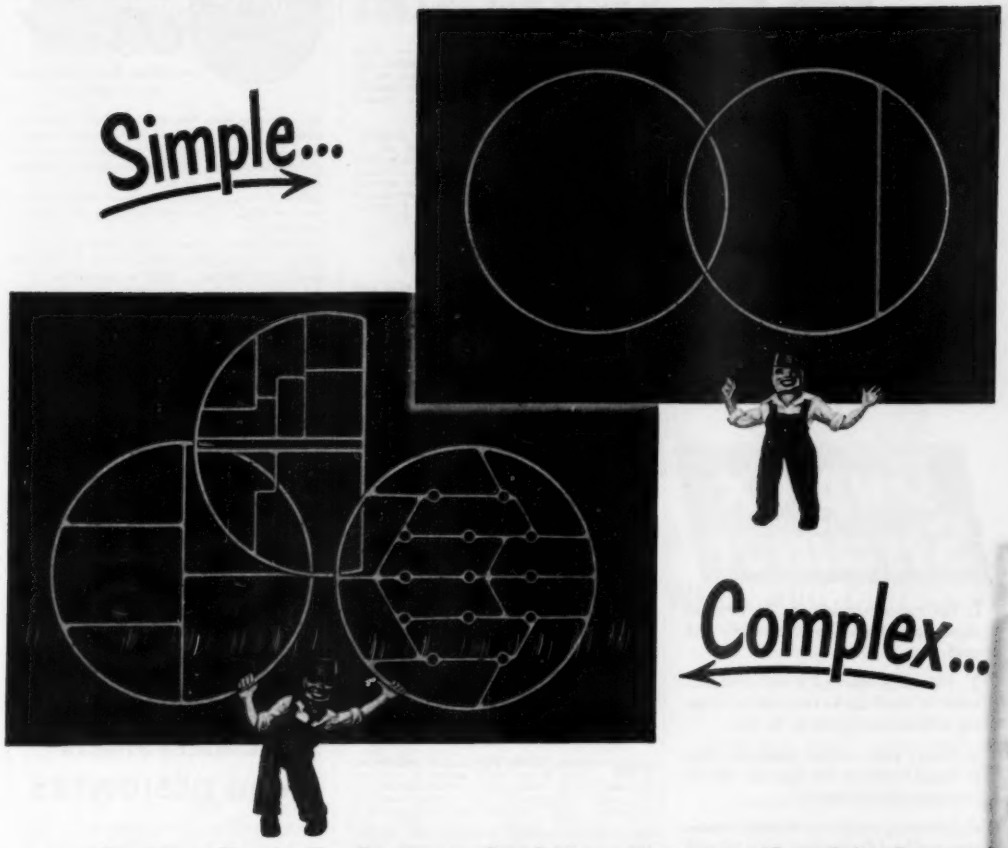
248 Handbook on Fittings and Flanges Catalog wf-1950, 88 pp, is packed with working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings in other metals. Grinnell Co., Inc.

249 How to Choose and Use Air Traps—Bulletin 202, 4 pp, describes a line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, drip points. Prices included. Armstrong Machine Works.

250 Safety Valve Engineering Data—How company's safety valve works and its important operating advantages are explained in Bulletin 707, 4 pp. Includes dimensions on flanged and welded inlet valve types, tables on superheat correction factor, capacities in pounds of saturated steam per hour. Manning, Maxwell & Moore, Inc.

251 Flanges for Severe Service—This 4-pp bulletin describes and illus-

Precision-made to the design you need . . .



Goetze Heat Exchanger Gaskets stay on the job longer!

Whether your specifications call for a simple or complex design, you can depend on Johns-Manville Goetze heat exchanger gaskets to do the kind of sealing job that costs you less in the long run!

That's because they are carefully hand-tailored to assure the accuracy of fit so important in heat exchanger service. Every detail of construction reflects the craftsmanship that goes into the fabrication of these better gaskets. You'll find no wrinkles or cracks on the corners. Lap widths are ample, rib widths uniform.

More than 60 years of gasket-making experience is your further assurance that when you put a Goetze heat exchanger gasket on the job, you can count on it to *stay* on the job for a long time. For further details and a prompt estimate of cost, send us a blueprint or template. Just address Johns-Manville, Box 290, New York 16, New York.

Johns-Manville Goetze GASKETS

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7 ADVANTAGES of the Duplex Strainer

1. Full control obtained by 2½ turns of single handwheel. Operates rapidly and easily.

2. TWO large identical basket strainers, either of which can be removed for cleaning without interruption to the flow.

3. Rotary valve motion eliminates dirty or clogged seats as the discs are always in contact with the seats.

4. Operating mechanism is on the downstream side of the strainer, not in the path of flow and in contact with clean strained liquid only.

5. Designed for minimum pressure drop and low maintenance (only one stuffing box).

6. Used on house service lines in major generating stations and on fuel oil lines in utility and heavy industrial plants.

7. Available in various metals and alloys for nearly all liquids. 4-inch to 24-inch pipe sizes.

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trates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Also covers a flexible rubber pipe for abrasive or corrosive material, and an acid- and corrosion-resistant duct. Goodall Rubber Co.

252 **To Get at those Valves** — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels and makes them readily accessible. Prices given. Babbitt Steam Specialty Co.

253 **Strainers and Separators** — Bulletin R-46-50A is a 16-pp catalog on T-type strainers, suction strainers, multi-flow and receiver separators. Contains dimensions, weights, prices. Shows how several types have been redesigned for increased efficiency. Dimensions, service pressure ratings. American District Steam Co.

FUEL OILS, LUBRICANTS

254 **Fuel Oil Treatment** — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. E. F. Drew & Co., Inc.

255 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Standard Oil Co. (Indiana).

256 **Grease Application Devices**—The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven grease lubricators, explaining such points as the judicious use of pressure measured lubrication, pumpability characteristics of lubricants. The Texas Co.

257 **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-pp illustrated book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. Cities Service Oil Co.

258 **Diesels, Their Fuels and Lubricants** —This 48-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. Includes a discussion of fuel and lubricating oil required. Sinclair Refining Co.

COAL, ASH HANDLING

259 **Spreader Stoker** — Bulletin 890, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages of this type of stoker, including its efficiency in the burning of many grades of coal and in handling of fluctuating loads. Power-operated and hand-operated dumping grates and stationary grates are shown. Detroit Stoker Co.

260 **Coal Handling Equipment** — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

261 **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

262 **Spreader Stoker Data**—This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

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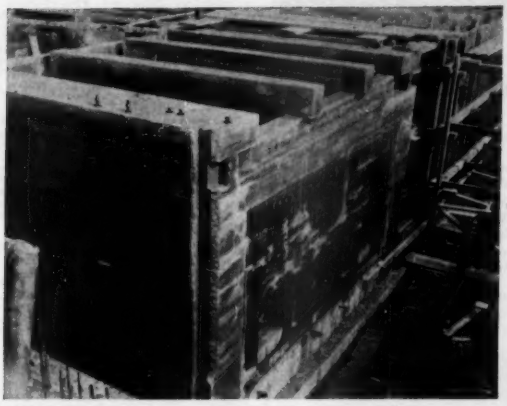

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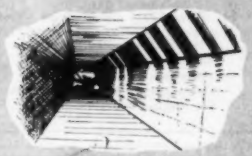

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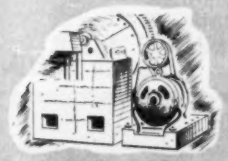

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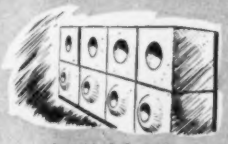

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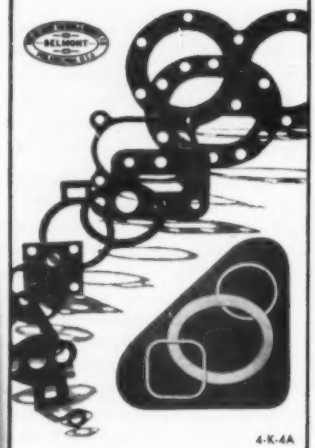

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(Continued from page 122)

FANS, BLOWERS

274 **Mechanical Draft Fans**—An extensive line of mechanical draft fans for both forced and induced draft service is described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, also includes performance curves showing efficiencies of various types of fans. Gives details of construction features, drive arrangements, mounting methods. The Green Fuel Economizer Co., Inc.

275 **Axial Flow Blowers**—In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. Also describes draft inducers. L. J. Wing Mfg. Co.

DUST COLLECTING

276 **Fly Ash Elimination**—Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Also gives excellent engineering data on single and double hopper installations. Western Precipitation Corp.

277 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Prat-Daniel Corp.

PACKINGS

278 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes recommendations. Johns-Manville.

279 **Teflon Packings**—Form AD143 offers 8 pp of information on packings and gasketing material made of Teflon, giving properties, typical and special applications. Styles and types are pictured, construction described, sizes given. Includes chapter on toxicology of Teflon at extremely high temperatures. The Garlock Packing Co.

280 **Manual on Packings**—Containing 84 pp of helpful engineering and ordering information, Catalog 40 covers packings for practically every service. Illustrates each type, gives sizes, construction and application details. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

OTHER EQUIPMENT

281 **The ABC of CO_2**—An interesting, readable text covering the role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Includes scales of total heat losses of various types of coal, fuel oils and gas, also case histories of savings realized through increased CO_2 percentage. The Hays Corp.

282 **Cleaning Industrial Equipment**—This bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment includes information on pipe line cleaning and water well acidizing. Treats in detail methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

283 **Fundamentals of Hydraulics**—Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance trouble-shooting and selection of proper fluids. Besides offering well-organized reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators and apprentices. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Shows function of each component part. Sun Oil Co.

284 **Transmission Belting** — Catalog M-9022, 28 pp, gives detailed design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included. United States Rubber Co.

285 **Turbine Catalog Collection**—This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Includes data on speed increasing and reduction gears. The Terry Steam Turbine Co.

286 **Steels for Hot Spots** — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels. United States Steel.

287 **Industrial Dry Coolers** — Illustrated Bulletin DC-50, 12 pp, presents company's line of dry cooling equipment for small, "in-between" and heavy-duty cooling jobs and includes three new models. Two of these are small "portable" units and the third a medium-size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oil, fluids of refining stages. Includes dimensions and weights, also rating tables for cooling water. The Marley Co., Inc.

288 **Index to Information** — Compiled to help power engineers obtain literature wanted on chemical proportioning equipment, volumetric and gravimetric feeders, and recording, indicating and control instruments, 4-pp Bulletin BIF-1 describes briefly 36 available bulletins covering this equipment. BIF Industries.

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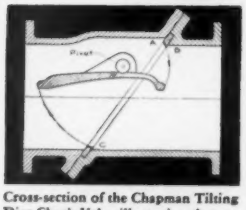

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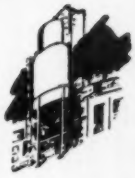

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